



INSTRUCTIONS

CONTROL EQUIPMENT

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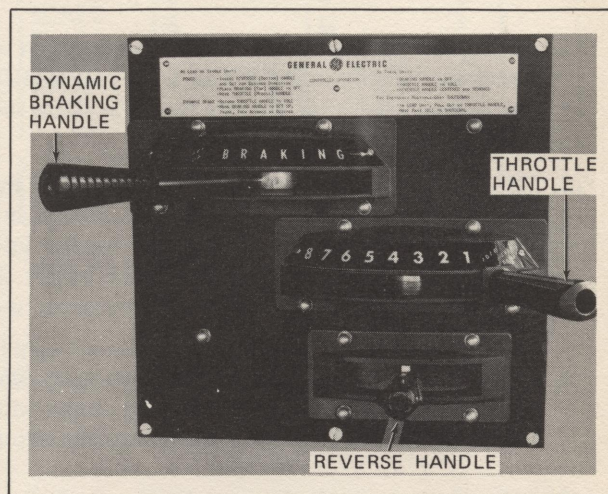


FIG. III-1. TYPICAL KC108 MASTER CONTROLLER, WITH BRAKING HANDLE.

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INTRODUCTION

This section includes information about control equipment for Series-7 Locomotives. Control equipment consists of devices and panels which provide the means of control of the locomotive.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

MASTER CONTROLLER

DESCRIPTION

The Type KC108 Master Controller is a three-handle, manually-operated, set-up switch with which the operator can control the direction, speed and (if equipped) the dynamic braking output of the locomotive, Fig. III-1.

The controller has the following handles:

1. **REVERSE** - bottom handle—Determines direction of locomotive movement: REVERSE, OFF, FORWARD. Handle removable with Throttle handle in IDLE and Braking handle in OFF.
2. **THROTTLE** - middle position—Controls speed of the diesel engine with SHUTDOWN, IDLE and eight power notches. Movement of handle into SHUTDOWN position to right of IDLE causes all engines in consist to shut down—for emergency use only.
3. **BRAKING** - upper position (if equipped)—For determining dynamic braking set-up and output with OFF, SET-UP positions and a BRAKING (B) sector.

Each handle opens and closes cam-operated contacts. Mechanical interlocking between the handles prevents improper operation of any handle.

MECHANICAL INTERLOCKING

Reverse Handle

With this handle removed, the controller is "locked-up." Neither the Brake handle nor the Throttle handle can then be moved. At lock-up, the Throttle handle is in IDLE position. Only when the Reverse handle is inserted can the Throttle handle be advanced thru the full engine speed range.

The Reverse handle cannot be moved from FORWARD or REVERSE when the Throttle handle is in Notch 1 or higher.

The Reverse handle cannot be moved from FORWARD or REVERSE when the Braking handle is advanced to SET-UP or BRAKING (only applies when Braking is included).

Throttle Handle

This handle cannot be moved to Notch 1 or higher if the Braking handle is advanced to SET-UP or any Braking position.

The Throttle handle can be placed in the emergency SHUTDOWN position under any operating condition except when the Reverse handle is removed.

The Throttle handle grip must be pulled outward (compress spring) to move from IDLE to SHUTDOWN position, and the Reverse handle must be inserted.

Braking Handle

This handle cannot be moved when the Reverse handle is in OFF (center) position; it must be in either FORWARD or REVERSE and the Throttle handle in IDLE or SHUTDOWN positions.

The Braking handle cannot be advanced for dynamic braking when the Throttle handle is in any notch between 1 and 8, or the Reverse handle is in OFF (center).

Data

Contact Finger: Throttle, Brake, Reverse

Overtravel (in.)

Throttle 3/32-4/32

Brake 3/32-4/32

Reverse 3/32-4/32

Tip Brake (in.)

Throttle 11/32-13/32

Brake 11/32-13/32

Reverse 11/32-13/32

Tip Pressure (lb.)

Throttle 3/4-1.0

Brake 3/4-1.0

Reverse 3/4-1.0

INSPECTION AND MAINTENANCE

General

Periodically, the control stand cover over the back of the controller should be removed and the following inspections made:

1. Full contact must be obtained on all sets of contact fingers.
2. Examine contact surfaces for burning and wear. Replace badly worn, burned or pitted contacts. Contacts may be filed smooth with a fine file. **DO NOT USE SANDPAPER OR EMERY CLOTH.**
3. Contact tip pressure is the force the compression spring applies to keep the finger against the stationary contact. Compare the contact tip pressure with values given in "Data" section. Measure the pressure as follows:
 - a. Use a spring scale with a hook which can be inserted in the contact loop, Fig. III-2.

FIG. III-2, E-18384B

FIG. III-3, E-18382A

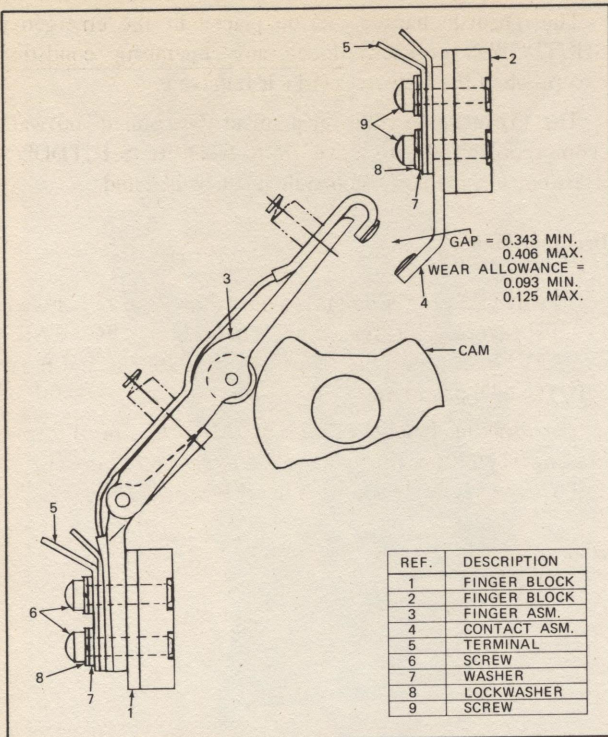


FIG. III-2. KC108 FINGER AND CONTACT ASSEMBLY.

- b. Insert a strip of paper between the stationary contact and movable finger.
- c. Pull on the spring scale until the finger separates sufficiently to allow the paper to be removed. Observe the scale value at this time. This should agree with the values given in the "Data" section. If it does not, the contact should be repaired or replaced.
4. Examine all wiring for loose connections and breaks in insulation. Replace damaged wiring.
5. Check handle movements for any binding or incorrect interlocking between handles.
6. Refer to Fig. III-3 for maintenance of the controller lighting circuit. The voltage should be from 6 to 8 v at the light socket. To replace the No. 44 pin-type pilot lamps, remove the two screws on the indicating strip involved. Slipping a short piece of suitable, small hose over lamp to remove it and to install new lamp is suggested.

CAUTION: Remove and replace one indicating strip at a time to prevent possible interchange of strips.

7. Check braking potentiometer (when equipped) for open or shorted condition. Resistance should measure from 45 to 55 ohms.

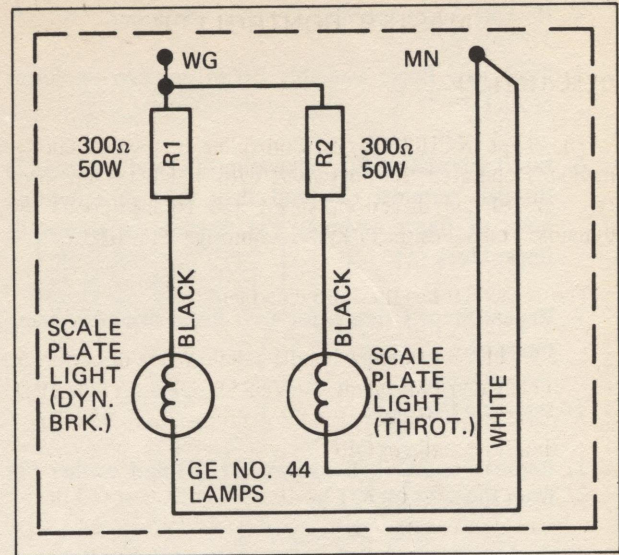


FIG. III-3. SCHEMATIC OF LIGHTING CIRCUIT.

Finger Contact and Replacement (See Figs. III-2 and III-4)

To replace a Finger:

1. Remove back cover from operator's stand to get at back of controller.
2. Remove screws (6), lockwashers (8) and washer (7) from finger block (1) to be replaced.
3. Remove terminal (5) with lead attached, and place it to one side. (If terminal is to be replaced, remove wire.)

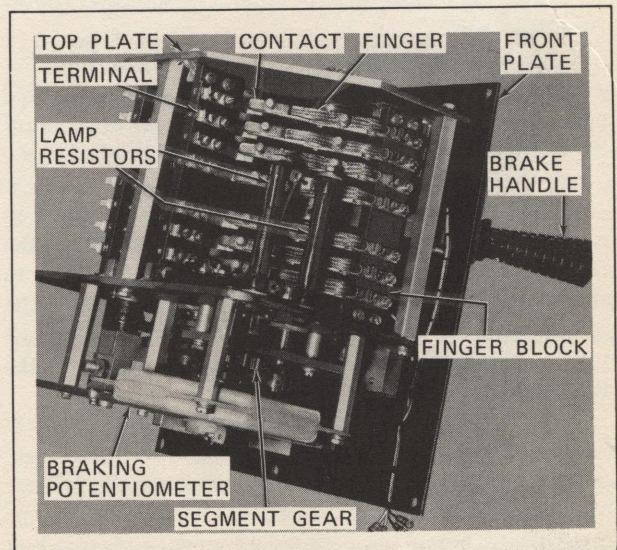


FIG. III-4. REAR VIEW OF CONTROLLER.

FIG. III-4, E-18383

4. Remove finger assembly (3) from controller.
5. Place new finger assembly (3) in position on finger block (1).
6. Insert screws (6) with lockwashers (8) and washers (7) through terminal (5), and then through mounting holes of finger assembly (3). Secure the screws to finger block (1).
7. Repeat Steps 1 thru 6 for each finger assembly being replaced.

To replace a Contact:

1. Remove screws (9), lockwasher (8) and washer (7) from finger block (2).
2. Remove terminal (5) with lead attached, and place it to one side. (If terminal is to be replaced, remove wire.)
3. Remove contact (4) from controller.
4. Insert screws (9) with lockwashers (8) and washers (7) through terminal and new contact (4). Secure the assembly to finger block (2) with screws (9).
5. Repeat Steps 1 thru 4 for each contact to be replaced. It is suggested they be done one at a time, so circuits will not be altered.

Replace cover on back of operator's stand.

REVERSER

DESCRIPTION

The Type DP26 Reverser is an electrically-controlled pneumatic switch which connects traction motor fields for FORWARD or REVERSE motor (armature) rotation.

When the Reverse lever on the controller is moved to either the FORWARD or REVERSE position, the corresponding contact behind the Reverse lever closes to energize either the forward or reverse magnet valve. The magnet valves, in turn, activate the main contacts to switch traction motor fields to correspond with the position of the Reverse lever.

The reverser consists of the following main parts: main contacts, interlocks, magnet valves and air cylinders. These main parts, along with other components, are mounted on a metal frame. Frame legs have special mounting feet to bolt the reverser in position.

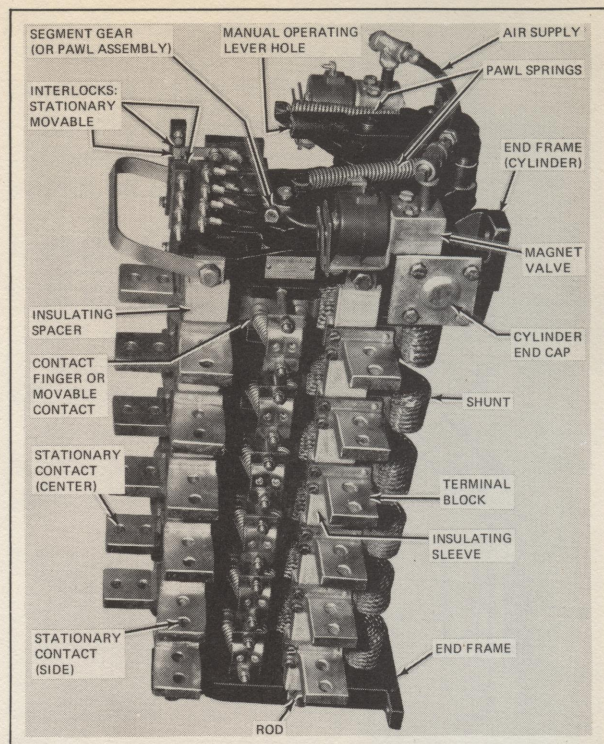


FIG. III-5. 17DP26A1 REVERSER.

Refer to Fig. III-5 for location of principle parts and to Fig. III-6 for typical contact numbering of the interlock and main contact terminals.

LUBRICATION

Apply several drops of D50E5B oil to the surface of each bearing or bushing. Grease the surface of both pawl rollers and the segment gear with D6A2C5.

INSPECTION AND MAINTENANCE

Preliminary Inspection

Check all bolted connections for proper tightness. Torque 5/16-18 bolts to 12-14 lb.-ft.; 3/8-16 bolts to 21-24 lb.-ft.; and 1/2-13 bolts to 40-45 lb.-ft.

Check condition of insulated rods, insulated sleeves and support blocks. Mark for replacement any rods, sleeves or blocks that are cracked, burned or broken.

Main Contacts and Contact Fingers

Mark for replacement any tips that are excessively worn, burned or pitted. Tips pitted less than 1/32 in. may be dressed with a fine flat file. Observe that contacts make, break, overtravel and align properly.

FIG. III-6, E-18823

FIG. III-7, E-6511A

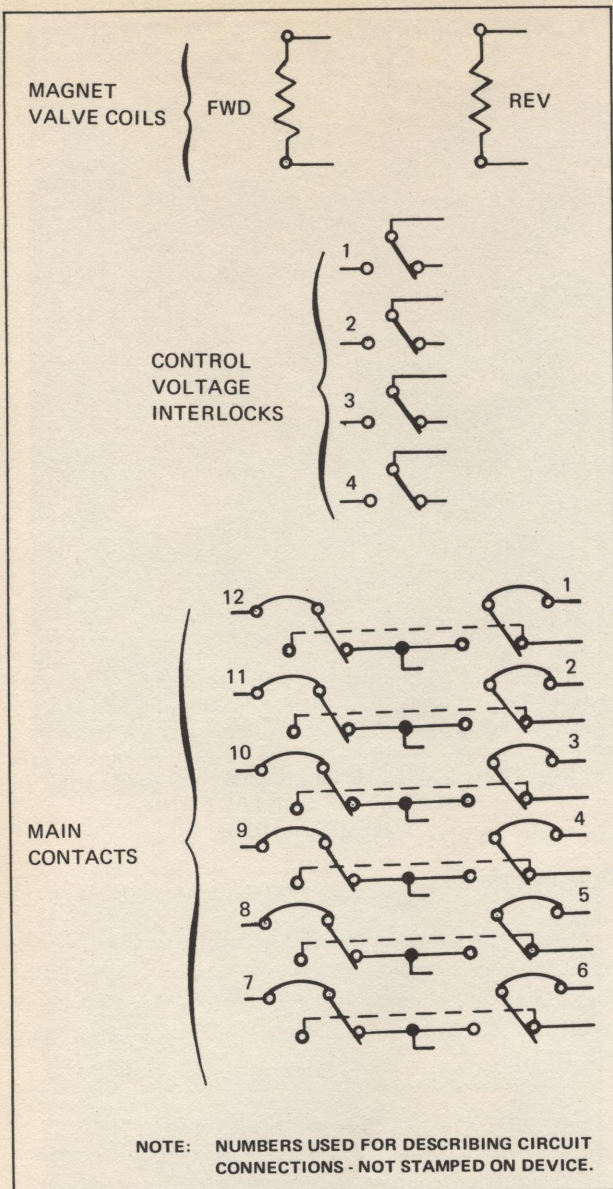


FIG. III-6. TYPICAL REVERSER CONTACT NUMBERING (FRONT VIEW, FORWARD POSITION).

Interlock Contacts

Mark for replacement any tips that are excessively worn, burned or pitted.

Drive Mechanism

Inspect the operation of the reverser, with control air supplied, by depressing the armatures of both magnet valves, one at a time. Sluggish operation may indicate:

1. Sticking or leaking magnet valves.
2. Leaking piston packing.

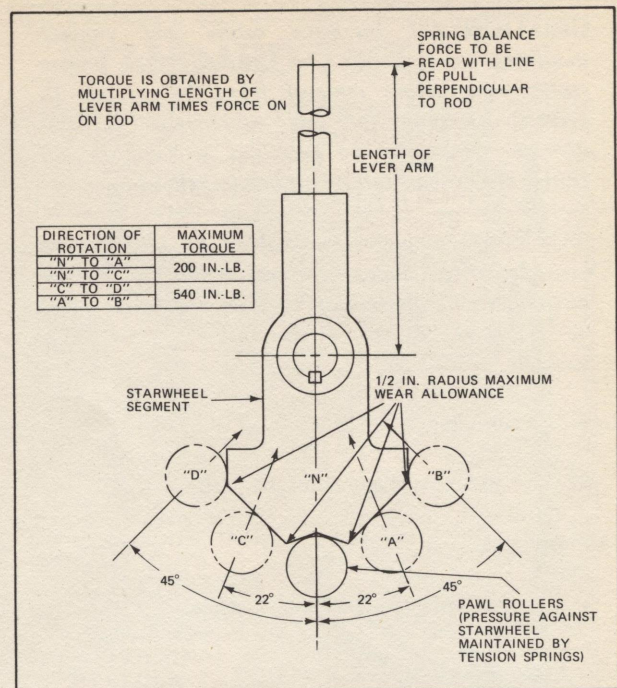


FIG. III-7. MEASUREMENT OF FORCE REQUIRED TO MANUALLY OPERATE REVERSER.

If the packing shows signs of wear, deterioration or if blowby exists, replace the packing. Check for air leaks at the hose and pipe connections, at the magnet valves and air engine cylinders with a soapy solution. Use normal locomotive control air pressure.

Reduce control air pressure to 45 psi and check for proper operation of reverser in both directions.

With control air shut off, check the torque required to operate the reverser manually by inserting a rod in the lever hole and pulling with a spring scale at a known distance. Measure torque from the NEUTRAL position over the starwheel notches in both directions, Fig. III-7. Check that the starwheel and pawl hold the contact fingers from completely unwiping with the air pressure shut off.

Main contacts should all close within 1/8 in. of each other at both positions. Also check that the main contacts close before, and open after the interlock contacts.

REPAIRS (ON LOCOMOTIVE)

It is anticipated that some busbars or cables must be disconnected to make reverser available for repair. Note, the right-hand door post of the main control compartment is removable for better access to the reverser area.

CAUTION: All busbars, cables and contact mounting rods must be marked for proper replacement before removal from the reverser to prevent misapplication and subsequent electrical damage. Care must be exercised in handling and storing the busbars to prevent bending the copper.

NOTE: When aluminum cables or busbars are connected to copper terminal blocks, special instructions on application of joint compound must be followed. Refer to the overall maintenance manual.

Interlock Contacts

Remove and replace any damaged parts.

Main Contacts

Stationary Contacts — Inside or Outside.

Cast Type

1. Remove the 1/2-in. bolts holding the insulated support rod (with damaged contact) to the end frames.
2. Remove the rod and stationary contacts.
3. Slide the insulator spacers and stationary contacts from the insulated rod; repair or replace the contacts.
4. Reassemble in reverse order.

Formed Type

1. Remove clamp bolt and metal spacer from damaged stationary contact.
2. Remove contact from insulated rod.
3. Repair or replace damaged contact.
4. Reassemble in reverse order.

Contact Fingers

1. Remove the two bolts holding the terminal block of the flexible shunt to the insulated support rod, Figs. III-8 and III-9.
2. Remove the nuts holding the retaining plate to the contact finger block support studs.
3. Remove and repair or replace the contact finger assembly.
4. Reassemble in reverse order.

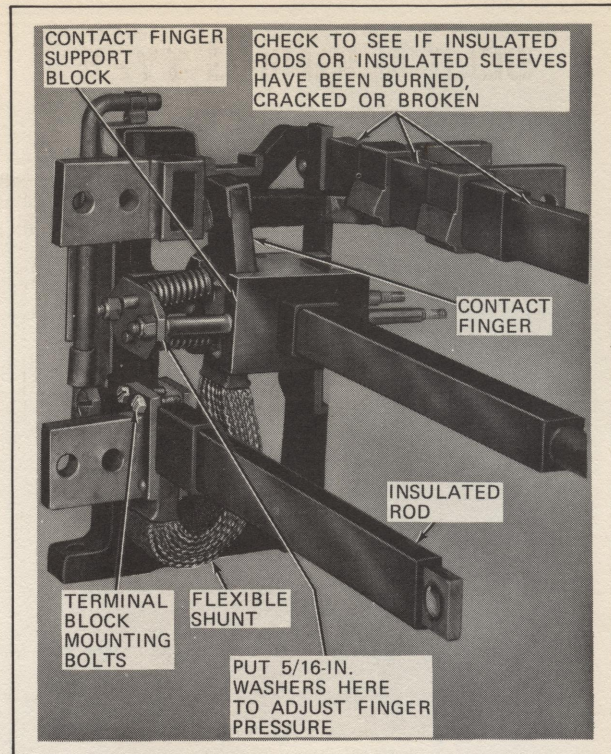


FIG. III-8. LOWER END FRAME AND PARTIAL ASSEMBLY OF CONTACT AND SUPPORT PARTS.

Drive Mechanism

Normally, a damaged segment gear-support assembly can be disassembled by removing the two pawl springs so the four 3/8-in. mounting bolts can be unbolted. Replace or repair any damaged parts and reassemble in reverse order, Fig. III-10.

CAUTION: After reassembly, check all connection and retaining bolts for tightness. Check connections and insulated contacts for proper location as shown on the locomotive diagram, since rods are not keyed to prevent inverting them. Improper assembly can result in damage to electrical equipment.

MAGNET VALVES

Description

The Type MV38 Magnet Valves are used on the DP26 reverser. These valves control the air flow to the air cylinders which, in turn, control the action of the reverser.

A magnet valve has the following main parts: frame, coil, armature, valve body, valve, valve stem and terminals. These main parts are assembled with others to make the complete valve assembly as shown in Figs. III-11 and III-12.

SELF-ALIGNING TYPE

STANDARD TYPE

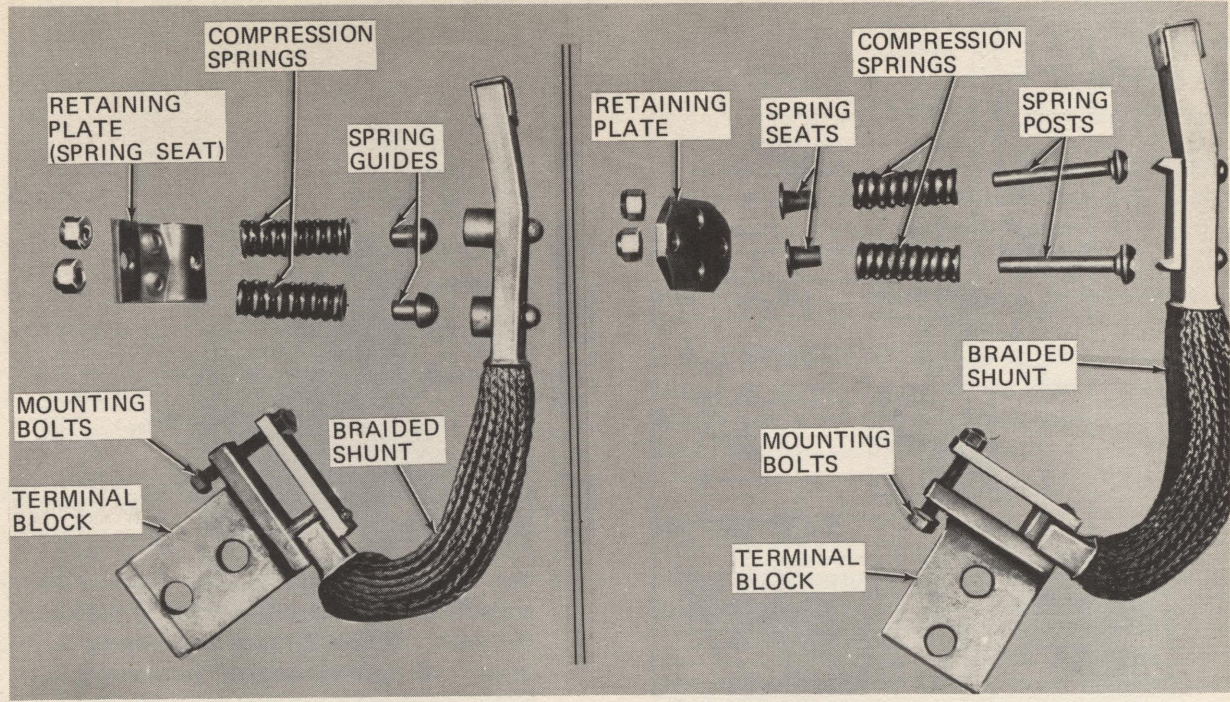


FIG. III-9. EXPLODED VIEW OF SELF-ALIGNING AND STANDARD FINGER ASSEMBLIES.

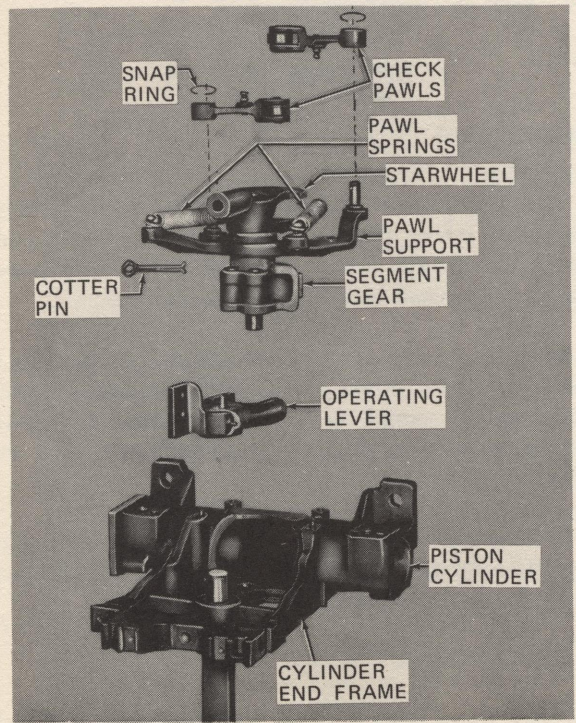


FIG. III-10. EXPLODED VIEW OF DRIVE MECHANISM PARTS.

Magnet Valve Data

Table III-I shows the coil resistance, volts continuous and amps required to operate the various forms of MV38 magnet valves.

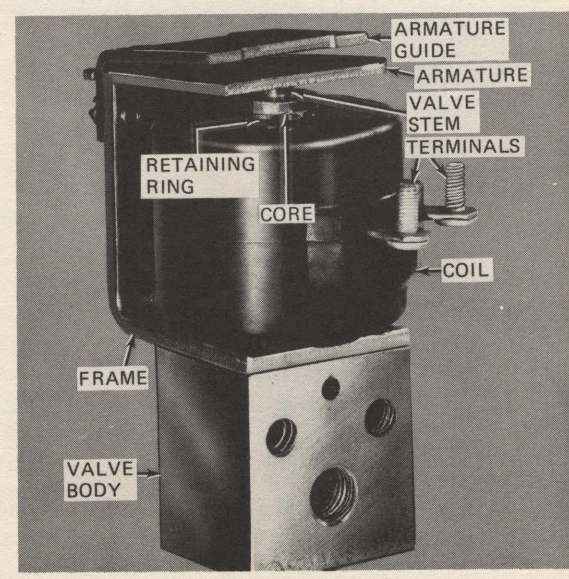


FIG. III-11. MV38 MAGNET VALVE.

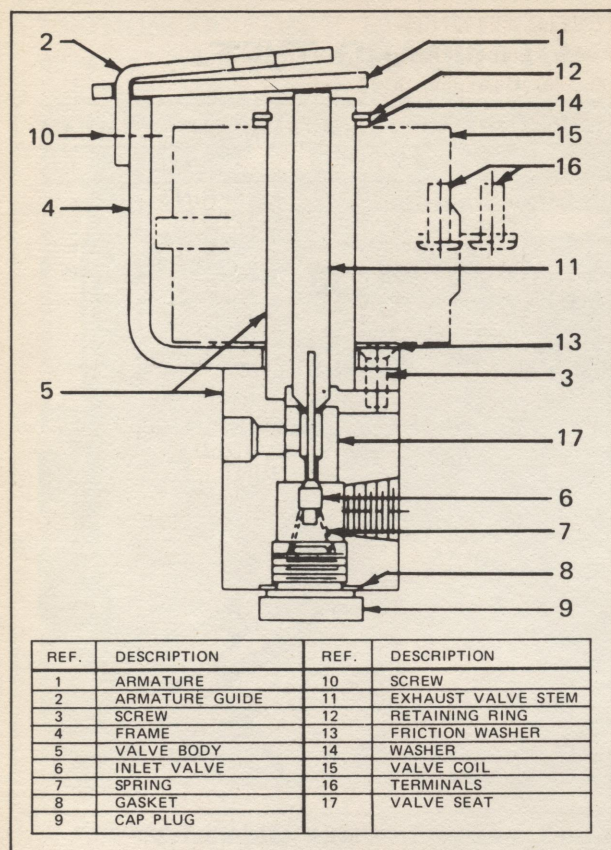


FIG. III-12. SECTIONAL VIEW OF MAGNET VALVE.

TABLE III-I, TYPE MV38 MAGNET VALVES

Coil Form	Resistance at 25 C (ohms)	Volts Continuous	Amps To Operate at 90 psi
1	336	88	0.108
2	128	55	0.181
6	775	135	0.069
8	3080	270	0.036
12	84.9	44.6	0.206

Amps required to operate at 70 psi are 91 percent of amps required to operate at 90 psi.

Amps required to operate when mounted upside down increase 15 percent.

Application at more than 90 psi is practical only under special conditions.

Inspection and Maintenance

The following procedure will assist in the inspection and maintenance of the magnet valves, Figs. III-12 and III-13.

1. Test the magnet valve operation by depressing the armature on the top of the magnet valve. If the valve

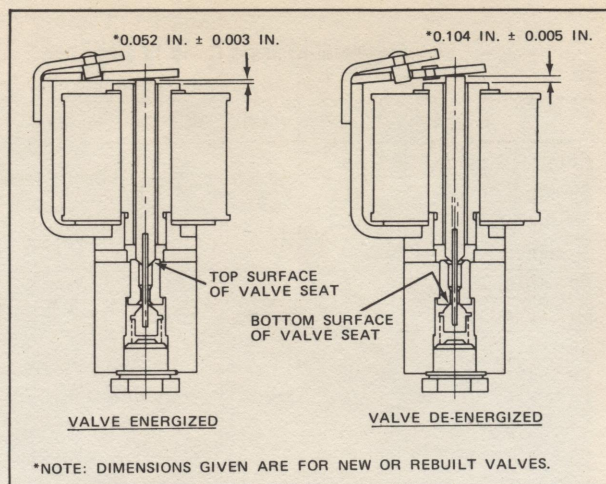


FIG. III-13. VALVE TRAVEL.

sticks, it must be cleaned. Refer to the applicable maintenance manual.

2. Test for leaks by applying soapy water to the pipe connections and exhaust port while air pressure is on the valve. Tighten all leaky connections. A small amount of leakage through the exhaust port is acceptable if the locomotive leak-down test can still remain in limits. If excessive leakage is found, disassemble the valve for cleaning. Refer to the applicable maintenance manual.

BRAKING SWITCH

DESCRIPTION

The Type GP19 Braking Switch is an electrically-controlled power switch which connects braking grids across the traction motor armatures and sets up power circuits for dynamic braking on the locomotive.

When the Selector or Braking Handle on the Controller is moved to the BRAKING position, electric-actuated magnet valves supply control air to the positioning air engine, causing the contacts on the Braking switch to close in one of two positions.

Refer to Fig. III-14 for location of principle parts, and to Fig. III-15 for typical contact numbering of the interlock and main contact terminals.

LUBRICATION

Apply several drops of D50E5B oil to the surface of each bearing or bushing. Grease the surface of both pawl rollers and the segment gear with D6A2C5.

INSPECTION AND MAINTENANCE

Preliminary Inspection

Check all bolted connections for proper tightness. Torque 5/16-18 bolts to 12-14 lb.-ft.; 3/8-16 bolts to 21-24 lb.-ft.; and 1/2-13 bolts to 40-45 lb.-ft.

Check condition of insulated rods, insulated sleeves and support blocks. Mark for replacement any rods, sleeves or blocks that are cracked, burned or broken.

Main Contacts and Contact Fingers

Mark for replacement any tips that are excessively worn, burned or pitted. Tips pitted less than 1/32 in. may be dressed with a fine flat file. Observe that contacts make, break, overtravel and align properly.

Interlock Contacts

Mark for replacement any tips that are excessively worn, burned or pitted.

Drive Mechanism

Inspect the operation of the switch, with control air supplied, by depressing the armatures of both magnet valves one at a time. Sluggish operation may indicate:

1. Sticking or leaking magnet valves.
2. Leaking piston packing. If the packing shows signs of wear or deterioration or if blowby exists, replace the packing. Check for air leaks at the hose and pipe connections, at the magnet valves and air engine cylinders with a soapy solution. Use normal locomotive control air pressure.

Reduce control air pressure to 45 psi and check for proper operation of the Braking switch in both directions.

With control air shut off, check the torque, Fig. III-16, required to operate the Braking switch manually by inserting a rod in the lever hole and pulling with a spring scale at a known distance. Measure torque from the NEUTRAL position over the starwheel notches in both directions. Check that the starwheel and pawl hold the contact fingers from completely unwiping with the air pressure shut off.

Main contacts should all close within 1/8 in. of each other at both positions. Also check that the main contacts close before, and open after the interlock contacts.

FIG. III-14, E-14000A

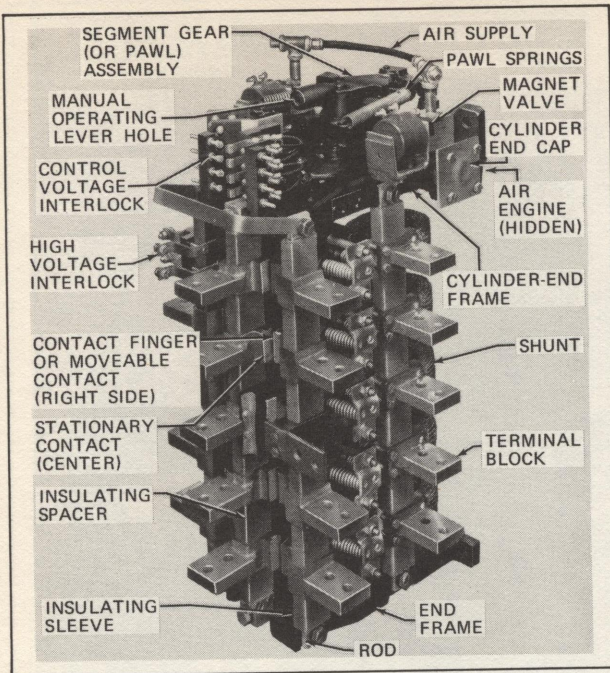


FIG. III-14. 17GP19L1 BRAKING SWITCH.

FIG. III-15, E-17788A

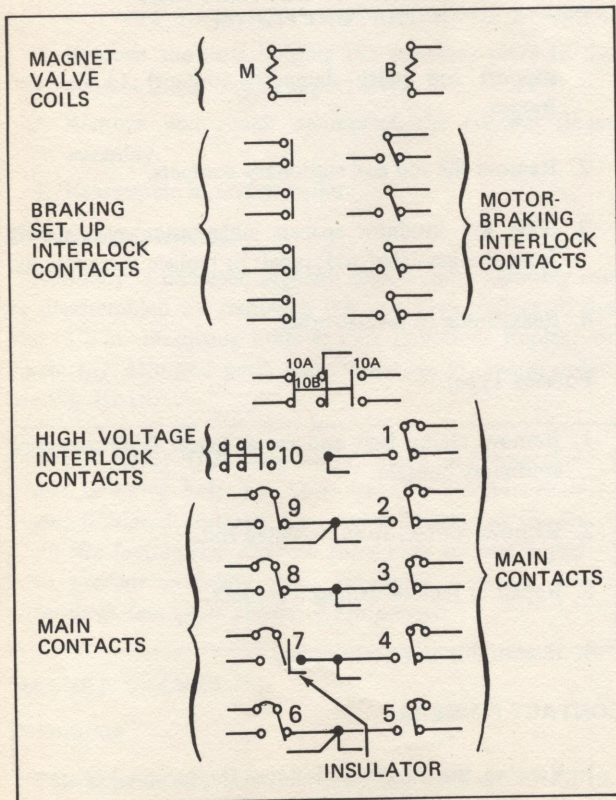


FIG. III-15. TYPICAL CONTACT NUMBERING ON A BRAKING SWITCH (VIEWED FROM FRONT).

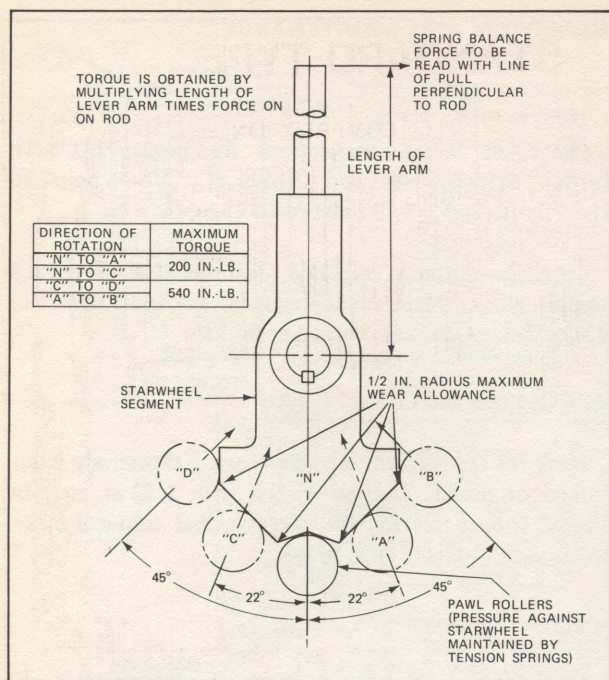


FIG. III-16. MEASUREMENT OF FORCE REQUIRED TO MANUALLY OPERATE BRAKING SWITCH.

REPAIRS (ON LOCOMOTIVE)

It is anticipated that some busbars or cables must be disconnected to make Braking switch available for repair. Note, the right-hand door post of the main control compartment is removable for better access to the Braking switch area.

CAUTION: All busbars, cables and contact mounting rods must be marked for proper replacement before removal from the Braking switch to prevent misapplication and subsequent electrical damage. Care must be exercised in handling and storing the busbars to prevent bending the copper.

NOTE: When aluminum cables or busbars are connected to copper terminal blocks, special instructions on application of joint compound must be followed. Refer to the overall maintenance manual.

INTERLOCK CONTACTS

Remove and replace any damaged parts.

MAIN CONTACTS

Stationary Contacts – Inside or Outside

Cast Type:

1. Remove the 1/2 in. bolts holding the insulated

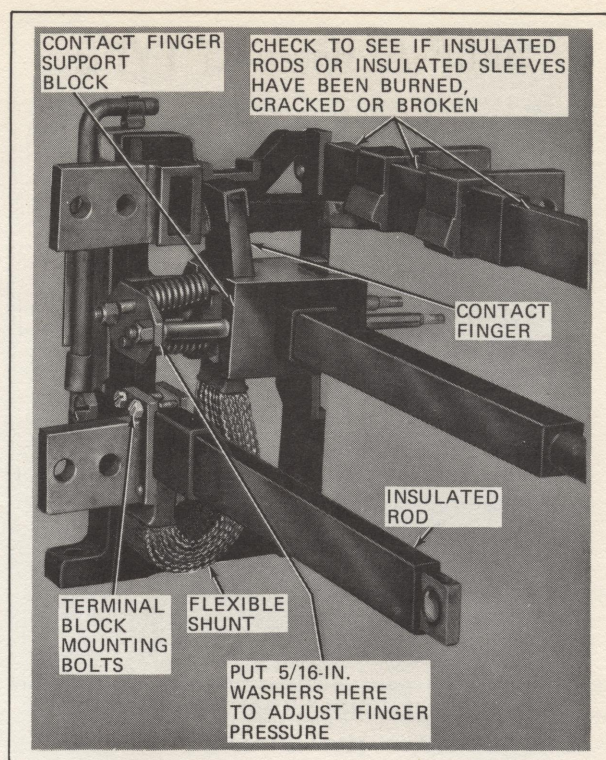


FIG. III-17. LOWER END FRAME AND PARTIAL ASSEMBLY OF CONTACT AND SUPPORT PARTS.

support rod (with damaged contact) to the end frames.

2. Remove the rod and stationary contacts.
3. Slide the insulator spacers and stationary contacts from the insulated rod; repair or replace the contacts.
4. Reassemble in reverse order.

Formed Type:

1. Remove clamp bolt and metal spacer from damaged stationary contact.
2. Remove contact from insulated rod.
3. Repair or replace damaged contact.
4. Reassemble in reverse order.

CONTACT FINGERS

1. Remove the two bolts holding the terminal block of the flexible shunt to the insulated support rod. See Figs. III-17 and III-18.

FIG. III-16, E-6511A

FIG. III-17, E-6504B

FIG. III-18, E-6501B

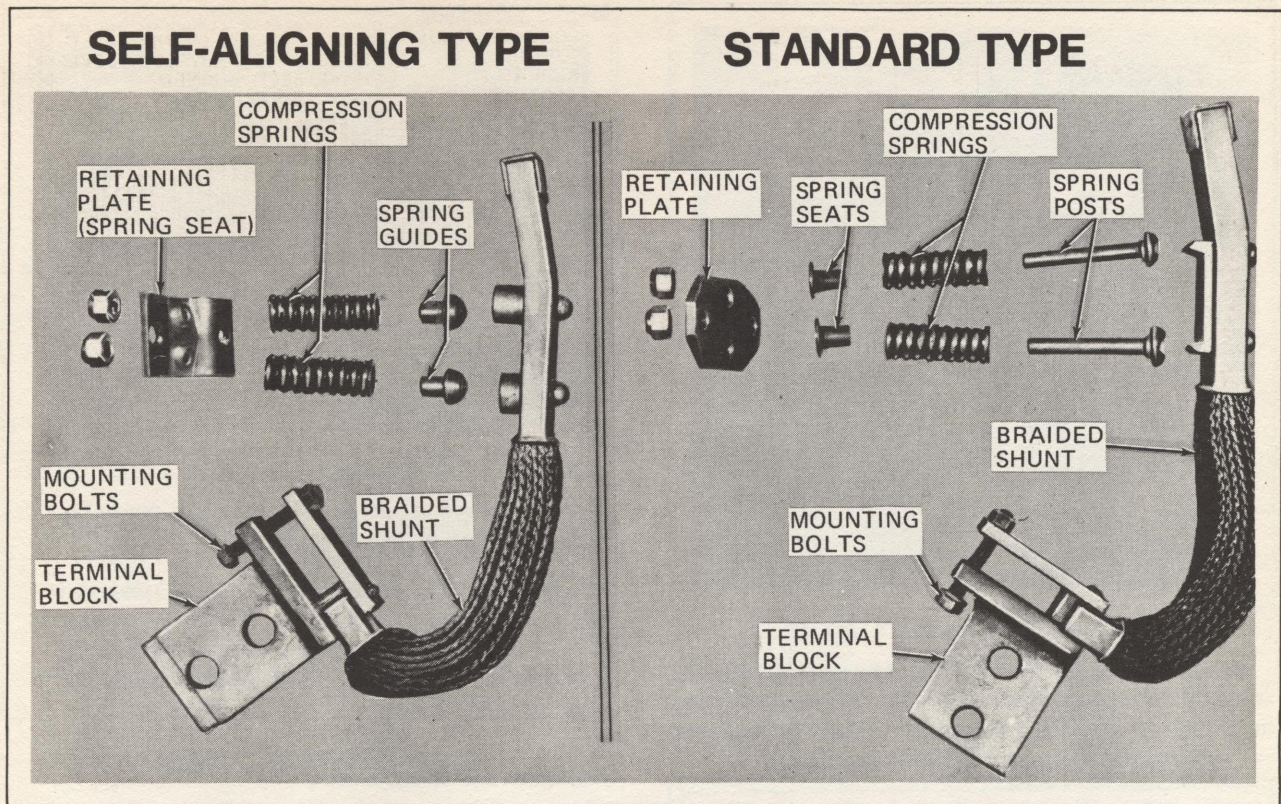


FIG. III-18. EXPLODED VIEWS OF STANDARD AND SELF-ALIGNING FINGER ASSEMBLIES.

2. Remove the nuts holding the retaining plate to the contact-finger block support studs.
3. Remove and repair or replace the contact finger assembly.
4. Reassemble in reverse order.

DRIVE MECHANISM

Normally, a damaged segment gear-support assembly can be disassembled by removing the two pawl springs so the four 3/8 in. mounting bolts can be unbolted. Replace or repair any damaged parts and reassemble in reverse order. See Fig. III-19.

CAUTION: After reassembly, check all connection and retaining bolts for tightness. Check connections and insulated contacts for proper location as shown on the locomotive diagram since rods are not keyed to prevent inverting them. Improper assembly can result in damage to electrical equipment.

MAGNET VALVES

Description

The Type MV38 Magnet Valves are used on the GP19. These valves control the air flow to the air cylinders which, in turn, control the action of the Braking switch.

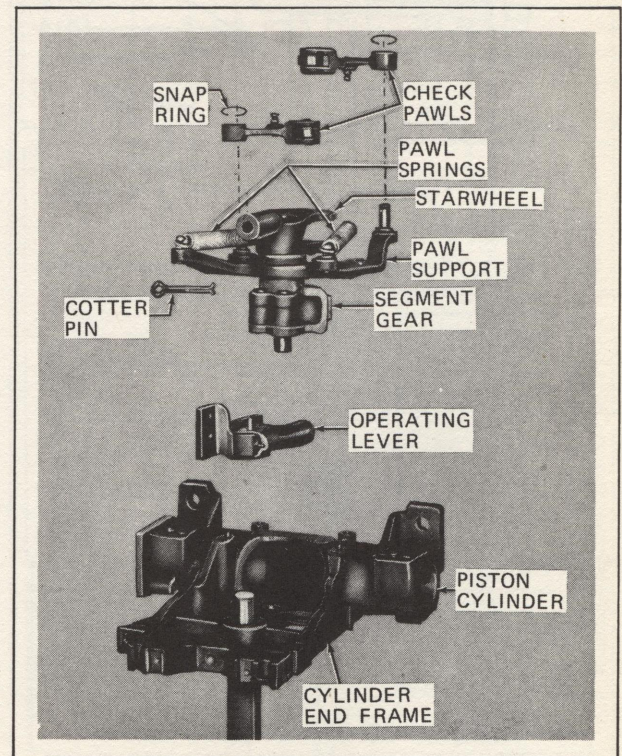


FIG. III-19. EXPLODED VIEW OF DRIVE MECHANISM PARTS.

FIG. III-19, E-6502A

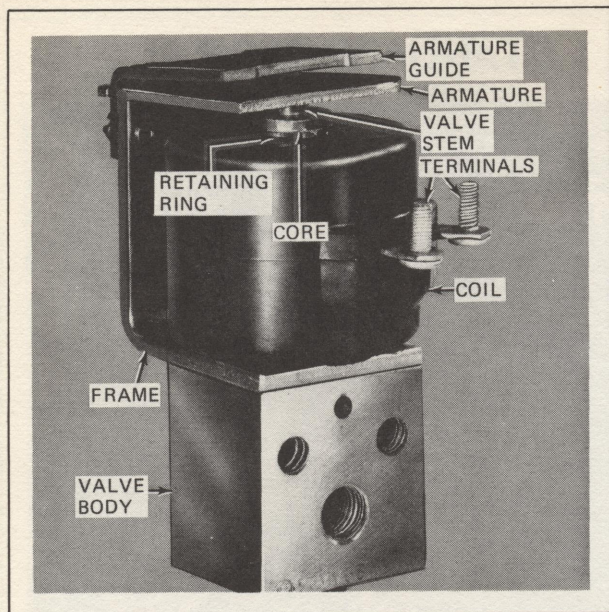


FIG. III-20. MV38 MAGNET VALVE.

A magnet valve has the following main parts: frame, coil, armature, valve body, valve, valve stem and terminals. These main parts are assembled with others to make the complete valve assembly as shown in Figs. III-20 and III-21.

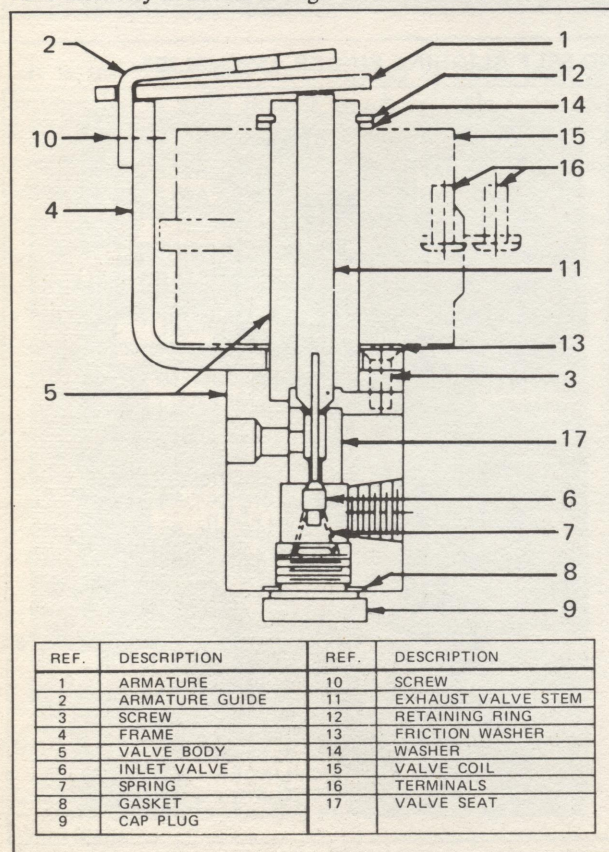


FIG. III-21. SECTIONAL VIEW OF MAGNET VALVE.

Magnet Valve Data

Table III-II shows the coil resistance, volts continuous and amps required to operate the various forms of MV38 magnet valves.

TABLE III-II, TYPE MV38 MAGNET VALVES

Coil Form	Resistance at 25 C (ohms)	Volts Continuous	Amps To Operate at 90 psi
1	336	88	0.108
2	128	55	0.181
6	775	135	0.069
8	3080	270	0.036
12	84.9	44.6	0.206

Amps required to operate at 70 psi are 91 percent of amps required to operate at 90 psi.

Amps required to operate when mounted upside down increase 15 percent.

Application at more than 90 psi is practical only under special conditions.

Inspection and Maintenance

The following procedure will assist in the inspection and maintenance of the magnet valves, Figs. III-21 and III-22.

1. Test the magnet valve operation by depressing the armature on the top of the magnet valve. If the valve sticks, it must be cleaned. Refer to applicable maintenance manual.
2. Test for leaks by applying soapy water to the pipe connections and exhaust port while air pressure is on

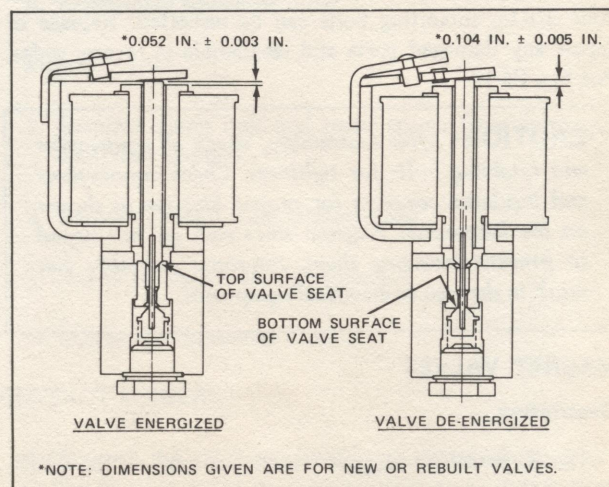


FIG. III-22. VALVE TRAVEL.

FIG. III-23, E-19658

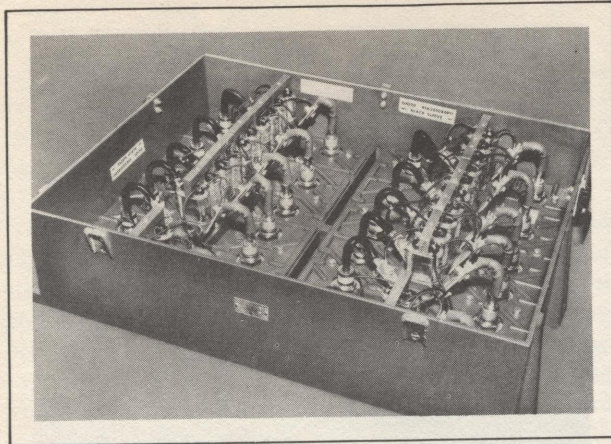


FIG. III-23. 17FM307B1 POWER RECTIFIER PANEL.

FIG. III-24, E-18357

the valve. Tighten all leaky connections. A small amount of leakage through the exhaust port is acceptable if the locomotive leak-down test can still remain in limits. If excessive leakage is found, disassemble the valve for cleaning. Refer to applicable maintenance manual.

POWER RECTIFIER PANEL

DESCRIPTION

The principle parts of the Type FM307 Power Rectifier Panel include high-current silicon rectifier diodes, heatsinks, resistors, capacitors and associated hardware, Figs. III-23 and III-24.

FIG. III-25, E-18365

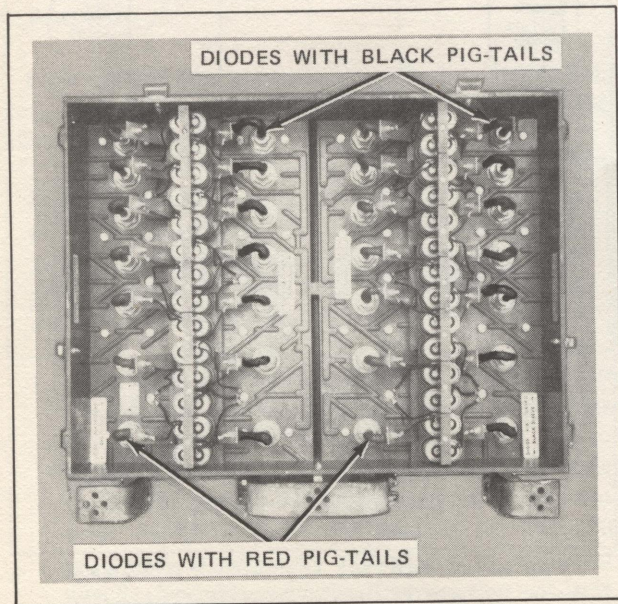


FIG. III-24. FORM A1 RECTIFIER PANEL (DIODES IN ALL POSITIONS).

FIG. III-26, E-18355B

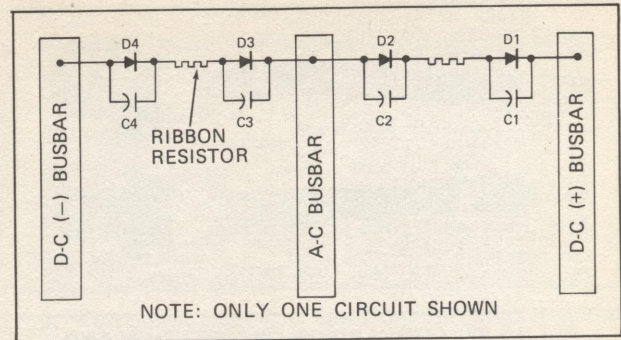


FIG. III-25. TYPICAL SINGLE CIRCUIT SCHEMATIC.

Electrically, the FM307 Panel has a number of parallel circuits from a d-c negative to the a-c, and from the a-c to the d-c positive busbars as shown in Figs. III-25 and III-26. Table III-III gives various model differences.

TABLE III-III, MODEL DIFFERENCES

FM307 Models	No. Parallel Circuits	Provision For Temperature Sensor	Negative Diode 41A281049-P	Positive Diode 41A281206-P
A1	7	X	11	1
A2	7	X	11	1
B1	6	X	11	1
B2	6	X	11	1
C1	5	X	11	1
C2	5	X	11	1

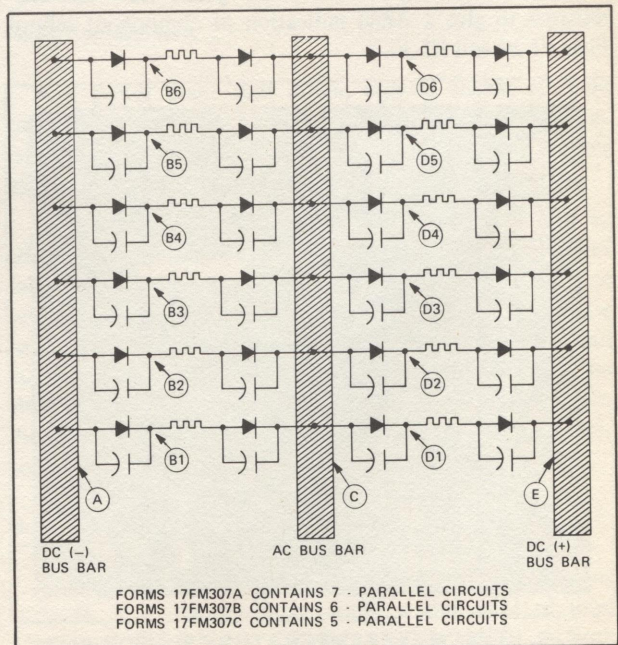


FIG. III-26. TYPICAL SCHEMATIC OF PANEL.

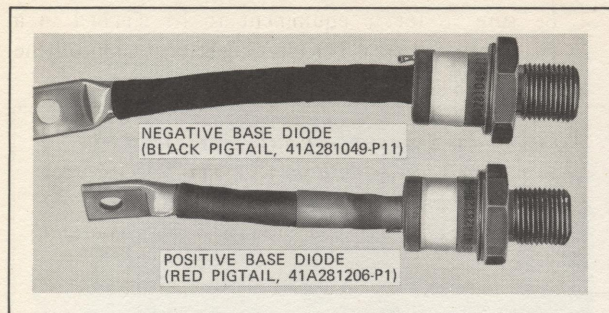


FIG. III-27. COMPARISON OF NEGATIVE AND POSITIVE BASE DIODES.

This panel uses two different types of diodes to simplify the circuits. These are positive (red 4-1/2 in. pigtail) and negative (black 5-1/2 in. pigtail) types. See Fig. III-27 for comparison of the two types.

The Form A Power Rectifier Panels contain seven parallel circuits having 28 high-current, 1200-volt silicon rectifiers, with a 0.5 mfd capacitor connected in parallel across each rectifier Fig. III-24. The panel contains four separate heatsink strips and 14 load-sharing ribbon resistors.

The left heatsink strip on all panels is prepared for a sensing element to monitor the panel temperature. The Form 1 panels have a cover plate over the sensor location, while Forms 2 and 3 have sensing elements installed. A terminal strip is also provided near the sensing element in the lower left corner of Forms 2 and 3 panels, Fig. III-28, for external wiring. The Form 4 panel has "tell-tale" resistors to give a visual indication of component failure, Figs. III-29 and III-30.

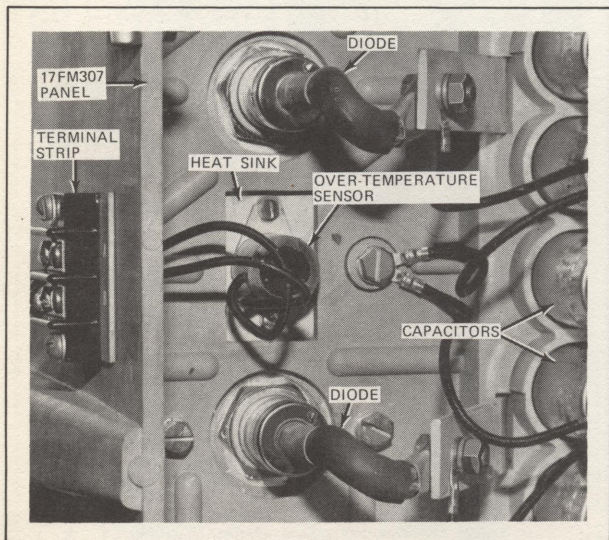


FIG. III-28. OVERTEMPERATURE SENSOR AND TERMINAL STRIP.



FIG. III-29. RECTIFIER PANEL SHOWING EARLY "TELL-TALE" RESISTORS SOLDERED TO MOUNTING STRIP.

Form B panels contain six parallel circuits having 24 high-current, 1200-volt silicon rectifiers, with a capacitor connected in parallel across each rectifier. These panels contain four separate heatsink strips and 12 load-sharing ribbon resistors. Schematically, the Form B has one less string of components than the Form A panels.

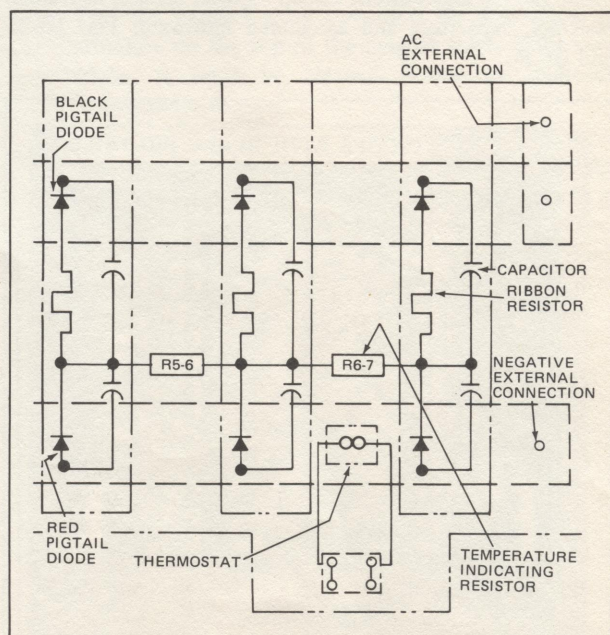


FIG. III-30. PARTIAL SCHEMATIC DIAGRAM SHOWING CONNECTION OF "TELL-TALE" RESISTORS BETWEEN ADJACENT CIRCUITS.

FIG. III-27, E-19659

FIG. III-28, E-21363

FIG. III-29, E-23389

FIG. III-30, E-23390

Form C panels contain five parallel circuits having 20 high-current, 1200-volt silicon rectifiers, with a capacitor connected in parallel across each rectifier. These panels contain four separate heatsink strips and ten load-sharing ribbon resistors. Schematically, the Form C has two less strings of components than the Form A panels.

Diodes must be checked periodically per an established schedule. Failed diodes must be detected and replaced to prevent overloading the remaining diodes in parallel circuits. Each interruption of a circuit forces the remaining circuits to share the same load. This causes higher average currents and an associated increase in operating temperature. The ultimate is the burn-up of a panel and possible single phasing of the alternator.

Special Tools and Equipment

1. Diode Wrench (Part 2X2823)
2. Torque Wrench (Part 147X1592)
3. Sealer (Part 1X7071)
4. Simpson 260 Analyser or equivalent
5. DeVilbiss Type DGD520 Cleaning Gun, or HM521 Spray Gun
6. Cleaning Solvent, Chlorothene N.U.
7. Diode Test Unit.

CLEANING

Blow out any dirt accumulation with dry, compressed, shop air. If this fails to remove the dirt, continue with the following cleaning method.

WARNING: *When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.*

1. Use a spray gun such as DeVilbiss Type DGD520 cleaning gun or HM521 oil spray gun. The two guns differ in that the DGD520 gun has a syphon hose to be inserted in a separate container of solvent while the HM521 gun has an attached quart container; not quite enough to clean one panel. If the DGD520 spray gun is used, the solvent can be syphoned directly from the container if an opening just large enough to permit inserting the syphon hose is provided.

2. Be sure to locate equipment to be cleaned in a well-ventilated area. The cleaning solvent Chlorothene N.U. is highly volatile and a degreasing agent.

WARNING: *Solvent should be used in a well-ventilated area, with a face mask to protect against breathing too much of the vapor. Also, avoid skin contact as it is a degreaser and will dry up natural skin oils.*

3. With power plant shut down, remove covers from the rectifier panels.
4. Spray diodes with solvent, making sure to soak the ceramic sleeve portion. Repeat the spray operation several times as surface appears dry after each application period. Remove the dirt with a clean cloth, but if still dirty, repeat spraying and wiping process.

TROUBLE-SHOOTING

The early detection and replacement of bad rectifying diodes (OPEN or SHORTED) will prevent catastrophic damage caused by a major rectifier panel failure.

Periodically remove covers and inspect panel components, wiring and cables for damage or overheating. Inspect the panel for dirt accumulation.

View panel for failed components and loose or broken connections. Check color of each "tell-tale" resistor. If one or more are darkened, check for failed power diodes or capacitors.

Panel Replacement

With power plant shut down, remove busbar or cable connections to the damaged panel. If hatch is provided over rectifier panels, use a crane to lift out damaged unit. Panels weigh about 126 pounds each.

Reverse the procedure to install new panel. Be sure to check the cable connectors on both ends of any a-c cables for possible damage or signs of overheating. Trouble here could result in single phasing the alternator even if the rectifier panels were working and cause loss of power and initiate heavy torsional vibration of the engine, the alternator and all the equipment mechanically connected to the alternator rotor. This includes the blower, air compressor and radiator fan.

Bolting Busbars Or Cables to Busbars

Since there is always a slight gap between mating surfaces, it is important to apply a thin coat of joint compound (T&B M-53, GE Part 41A204944P1) to both surfaces before bolting them together. This will prevent

dampness or moisture from accumulating in the joint and prevent subsequent corrosive action, high resistance, oxidation or loose connections at the junction. Also, the compound contains fine particles of a high-conductivity metal which "bite" into the contact surfaces, making a low-resistance joint.

Bolt Torquing

Proper torquing of the bolts is very important. See Table III-IV for torque values. An over-torqued joint is in trouble just as an under-torqued joint. The proper reassembly of plate washers or flat washers on the bolts is very important to properly distribute the pressure.

TABLE III-IV, TORQUE VALUES

Bolt Size	Torque (Lb.-Ft.)
5/16-18	12-14
3/8 -16	21-24
1/2 -13	40-45

Rectifier Diode

WARNING: Electric shock can cause serious or fatal injury. To avoid such injury, personnel should take and observe proper precautions.

1. A quick check of the rectifying diodes may be accomplished without disconnecting them, using the Test Unit; the schematic of which is shown in Fig. III-31. Complete instructions for building and using this unit can be obtained from your General Electric locomotive representative.
2. An alternate method of checking the individual rectifiers can be done with the setup shown in Fig. III-32. The braided terminal must be disconnected to make this test.

CAUTION: Make the following resistance checks with power removed from panel to prevent damage to analyzer.

Panel diodes can be checked for open or shorted condition by measuring forward and reverse resistance with an analyzer. It is not necessary to disconnect rectifier, resistor or capacitor leads from panel circuits for these checks.

Forward-Resistance Check

NOTE: The Forward Direction for diodes with black pigtail is from the pigtail to the base, while red pigtail diodes conduct in the Forward Direction from the base to the pigtail.

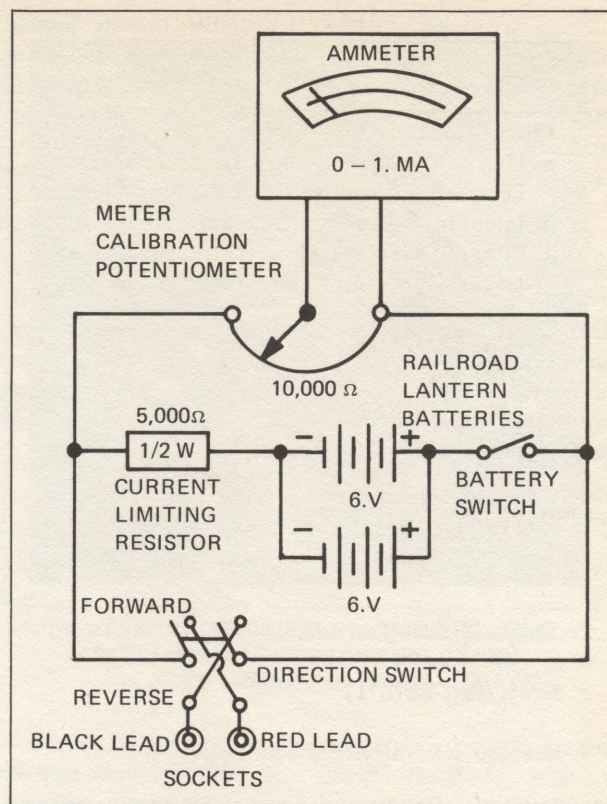


FIG. III-31. DIODE TEST UNIT SCHEMATIC.

1. Set analyzer on R x 100 scale.
2. Check forward resistance of each rectifier by placing (+) and (-) leads of analyzer on points indicated in Fig. III-26 with the following polarity:

Step	Analyzer		Test Limits
	(+)	(-)	
1	A	B	280 to 440Ω
2	B	C	280 to 440Ω
3	C	D	280 to 440Ω
4	D	E	280 to 440Ω

NOTE: Braided lead of rectifier with black pigtail is (+); with red pigtail is (-).

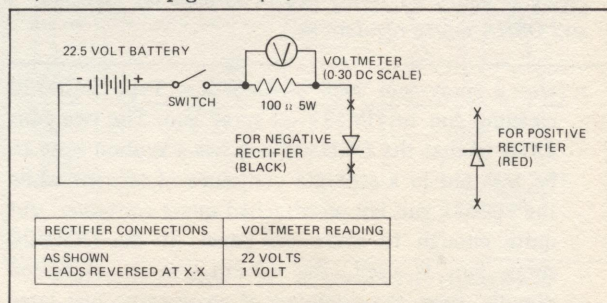


FIG. III-32. SILICON RECTIFIER DIODE VOLTAGE CHECK SCHEMATIC.

3. Check forward resistance across the four rectifiers in the lower string, as shown in Fig. III-26. Using the same polarity, transfer analyzer leads to comparable points in the other strings, thereby checking each rectifier in the panel. Forward resistance should be 280 to 440 ohms across each rectifier.

NOTE: If the forward-resistance value of a rectifier is not within the limits given, disconnect rectifier from circuit and make a forward and reverse voltage check, as shown in Fig. III-29.

Reverse-Resistance Check

1. Set analyzer on R x 10,000 scale.
2. Check reverse resistance of each rectifier by connecting analyzer leads in reverse of polarity indicated in Step 2 under Forward-Resistance Check. For example, A (–) to B (+). Reverse resistance should be 15,000 to 21,000 ohms.

Step	Analyzer		Test Limits
	(+)	(–)	
1	B	A	15,000 to 21,000Ω
2	C	B	15,000 to 21,000Ω
3	D	C	15,000 to 21,000Ω
4	E	D	15,000 to 21,000Ω

3. Check resistance of each rectifier in same manner in which forward resistance was checked.

NOTE: If the reverse-resistance value of a rectifier is not within the limits given, disconnect the rectifier from the circuit and make a forward and reverse voltage check, as shown in Fig. III-29.

Alternate Diode Check

A special test unit can be built locally to check the rectifier panel diodes without disconnecting them from the circuit. This unit measures voltage drops with diode energized with lantern batteries. Instructions for using the unit are given in the same publication. Request copies from your service engineer.

Removal

1. Remove power to panel.
2. Disconnect rectifier braid terminal.
3. Remove rectifier using special socket wrench (Part 2X1337). See Fig. III-33.
4. Remove rectifying diode from panel.

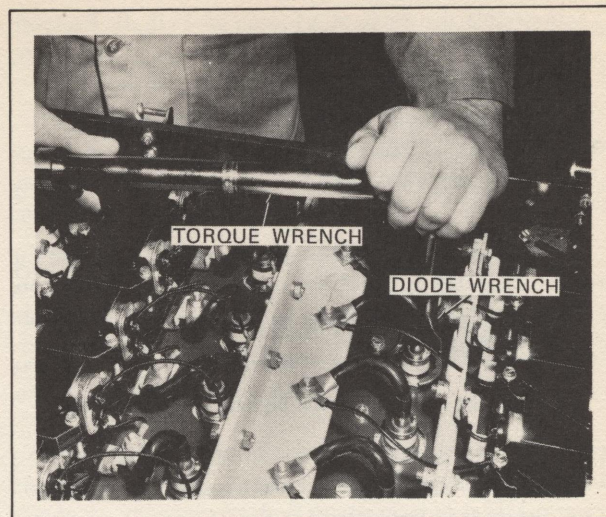


FIG. III-33. TORQUING DIODES ON TYPICAL PANEL.

Replacement

1. Apply a light film of Dow Corning 340* (Part 41A271707-P1) to the diode mounting face only, as shown in Fig. III-34.

CAUTION: Do not apply Dow Corning 340 to diode threads. This may prevent obtaining required torque values.

2. Replace the diode in reverse order. Make certain the capacitor connections are tight.

CAUTION: When replacing diode, locate braid so it does not touch or short against an adjacent component. Keep as far away from all other components as possible.

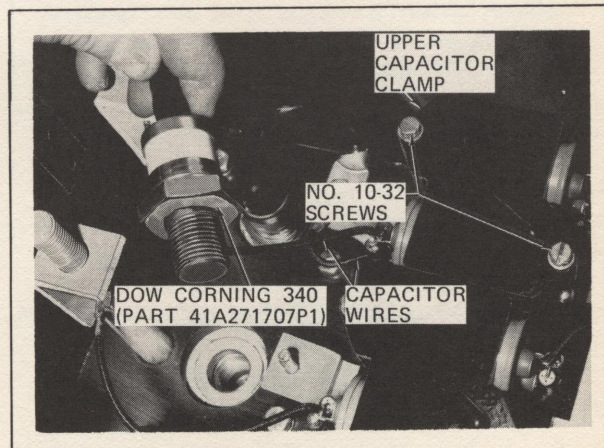


FIG. III-34. TYPICAL APPLICATION OF DOW CORNING 340.

*Product of Dow Corning Chemical Co.

3. Assemble the diode at a torque of 25 lb.-ft. Back off one half turn, and reapply torque of 25 lb.-ft. to obtain proper electrical contact and heat transfer.

Capacitor

Check

Check all soldered connections on capacitor terminals for broken connections. Check for open or shorted capacitors of the electrolytic type. Use an analyzer with an ohms scale of 0 to 10,000 or greater.

1. Adjust the analyzer to the highest resistance range.

CAUTION: *Discharge capacitors before disconnecting leads or testing with analyzers.*

2. Discharge capacitors through a 1000-ohm resistor connected between the terminals, then obtain full discharge by shorting the capacitors with an insulated jumper.

Replacement

1. Remove power from panel and discharge capacitor to be replaced.
2. Unsolder wires connected to capacitor.
3. Unsolder any resistor connected across capacitor terminals.
4. Loosen upper restraining clamp by removing the 10-32 nuts, washers and lockwashers holding it in place.
5. Remove the capacitor.
6. Replace the capacitor in reverse order.

Resistor

Check

Check ribbon resistor for looseness or shorted condition. Tighten or replace defective units.

Replacement of Tell-Tale Resistors

Resistors installed in FM307 panels after early 1977 plug into spring-clutch sockets on the terminal strips. The resistors can be replaced simply by pulling out the blackened one and inserting a new one.

On early panels, the resistors were soldered to connections on the terminal strip. Care must be taken when replacing one of these resistors to use a low-wattage soldering iron and heatsinks to prevent premature discoloration of the heat-sensitive tape on the new resistors. Tape turns black when temperature of resistors exceeds 120 C (248 F).

Replacement of Ribbon

1. Remove power from panel.
2. Remove the panel.
3. Remove clamp-block assembly containing capacitor.
4. Remove end of ribbon resistor connected to heatsink.
5. Remove other end of ribbon resistor connected to braided rectifier lead.
6. Replace ribbon resistor in reverse order.

Over-Temperature Sensor

The sensor, Figs. III-28 and III-29, should be checked annually for proper operation. Recommend removal of sensor and testing in an oven to prove circuit opens when temperature exceeds 99-104 C (210-220 F).

VOLTAGE REGULATOR PANEL

DESCRIPTION

All forms of the Type FH23 Voltage Regulator Panel have a voltage-regulator module as a basic component to keep the locomotive battery properly charged. It controls the output of a self-excited auxiliary d-c generator. The regulator senses the auxiliary generator output and adjusts the field current to maintain +74 vdc under various conditions of load and of engine rpm, Fig. III-35.

Component parts for the voltage regulator are assembled on a printed-circuit module (not a removable card), which is bracket-mounted to an insulated base along with resistors, diodes, transistors and a capacitor.

Test points, a monitor light, the fine-voltage adjustment potentiometer, a circuit breaker and the seven-pin connector, thru which all external connections are made, are all mounted on the front of the panel. The A1 model uses a 5-amp circuit breaker.

This section covers the basic 17FH23A1 panel, the voltage-regulator function and the additional protection

FIG. III-35, E-22258

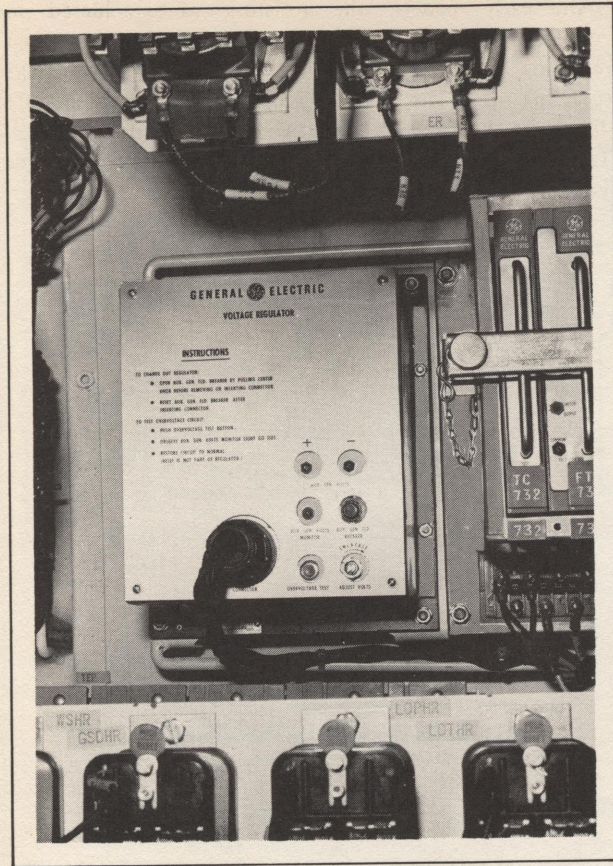


FIG. III-35. TYPICAL FH23 PANEL INSTALLATION.

module: Overvoltage Limit Protection. Other forms of the panel include one or both additional functions:

1. Negative Current Limit Protection
2. Positive Current Limit Protection

Each of these functions is assembled on an individual module, and several modules are mounted on a panel providing various forms of the FH23 voltage regulator. See Table III-V.

TABLE III-V, PANEL FORMS AND PROTECTIVE FUNCTIONS

Protective Function Modules	Position Of Mod.	Panel Form						
		A1	B1	C1	D1	E1	F1	F2
Voltage Regulator	1	X	X	X	X	X	X	
Negative Current Limit	2		X					X
Positive Current Limit	2			X		X		
Overvoltage	3				X	X	X	

A voltage regulator with the additional protection module will protect the control circuits and the locomotive battery against any excessive voltage due to a runaway failure of the regulator.

The schematic diagram for this model FH23 voltage regulator is shown in Fig. III-36.

The 17FH23D1 model differs from the 17FH23D2 model by having a circuit breaker, 23CB1, in the auxiliary generator field circuit which rates 5.0 amps; while the D2 model rates 7.5 amps.

OPERATION

The battery voltage is monitored from Terminals B to D on the module. The voltage is applied across the resistance network R2, R3, P1 and R4.

When the battery voltage reaches a preset overvoltage threshold, normally set at 85 vdc, transistor Q1 begins to conduct, allowing relay RL1 to pick-up. This supplies battery voltage to Terminal E thru two pairs of relay contacts in series (to increase the arc gap of the relay contacts). An external relay of LV66 type can then be used to interrupt the auxiliary generator shunt-field circuit.

The circuit can be tested by pressing the push-button switch on the face of the panel, since the circuit is brought out thru Terminals C and F.

MAINTENANCE

Periodically examine the panel and perform the following operations:

1. Inspect the panel for damaged or discolored components. Replace all faulty parts.

WARNING: When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.

2. Blow out dust and dirt with clean, dry compressed air.
3. Check for loose terminal connections and broken or damaged wiring. Tighten and replace if necessary.
4. Assure the modules are securely fastened in place.

CMR WHEELSLIP PANEL

DESCRIPTION

The Type FL80 CMR Wheel slip Panel, Fig. III-37, is part of the wheel slip detection system on six-axle diesel electric locomotives with rectified a-c propulsion systems. This

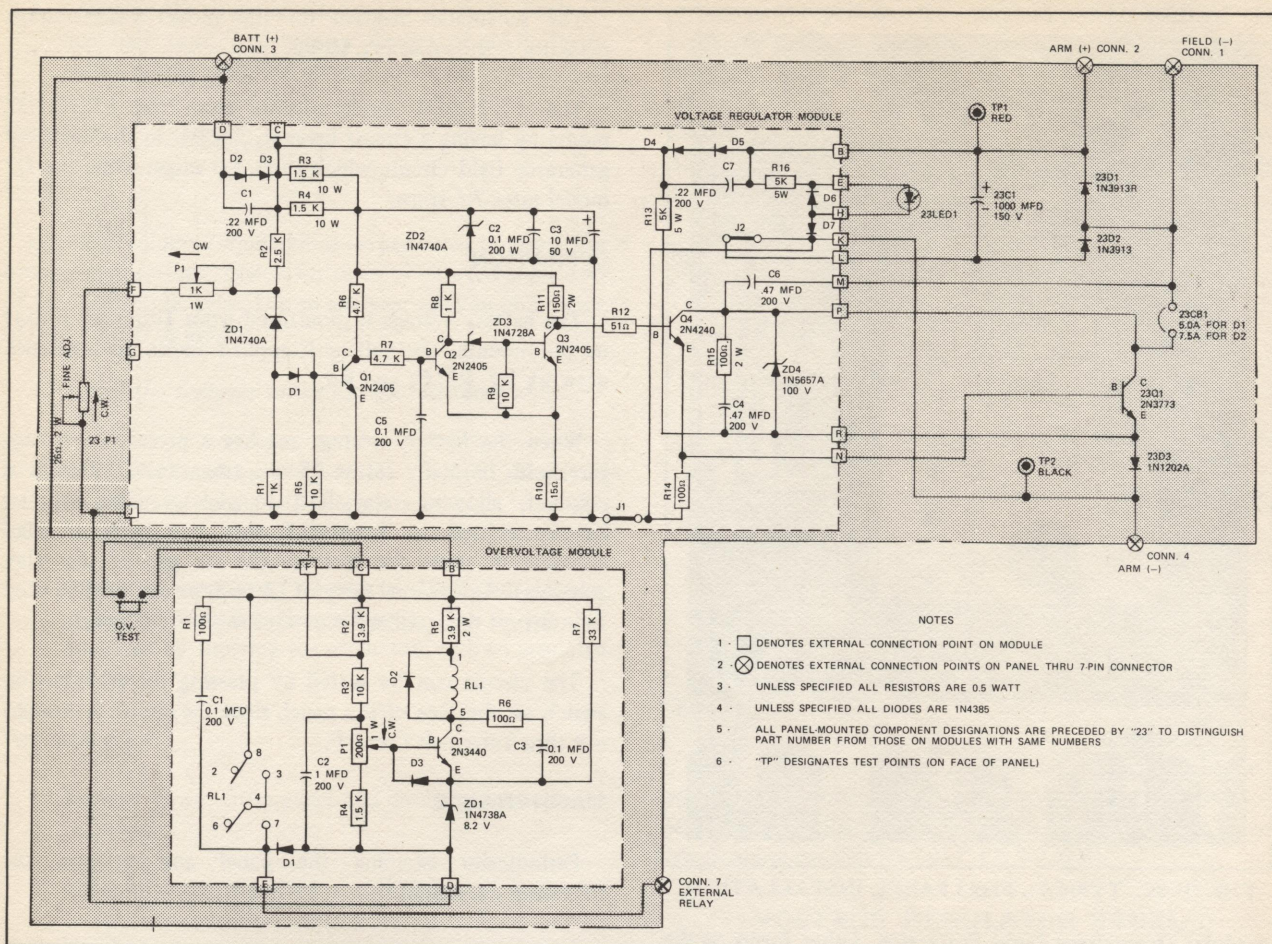


FIG. III-36. SCHEMATIC DIAGRAM OF 17FH23D1, D2 PANEL.

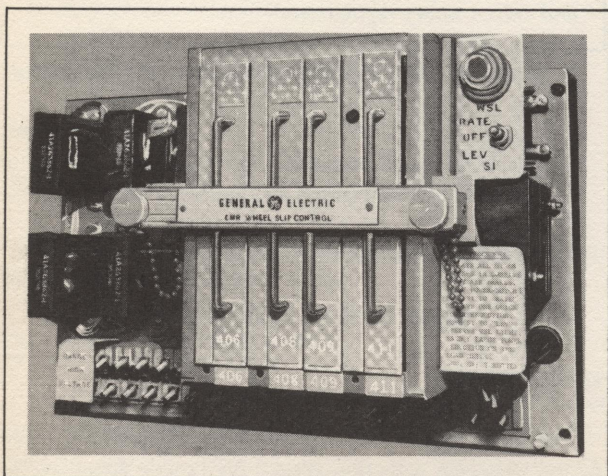


FIG. III-37. TYPICAL CMR WHEELSLIP PANEL (FL80).

wheelslip detection system is called the Current Measuring Reactor, or CMR type. It provides wheelslip/slide detection and correction by sensing current unbalance in the traction motor circuits, and reduces the applied power by adjusting the Excitation System, Fig. III-38. Fig. III-39 shows the schematic of the panel.

A test button is provided on the EC panel, in the operator's cab, to check RATE operation of the CMR wheelslip system.

A Toggle switch is provided on the panel to check RATE and LEVEL operation of the CMR system.

OPERATION

Monitoring currents are supplied from current measuring reactors in each traction motor circuit as the primary sensing elements. One axle alternator is used in this system to provide the locomotive speed signal for transition, overspeed and speedometer functions.

FIG. III-36, E-22269

FIG. III-37, E-16600

FIG. III-38, E-16601A

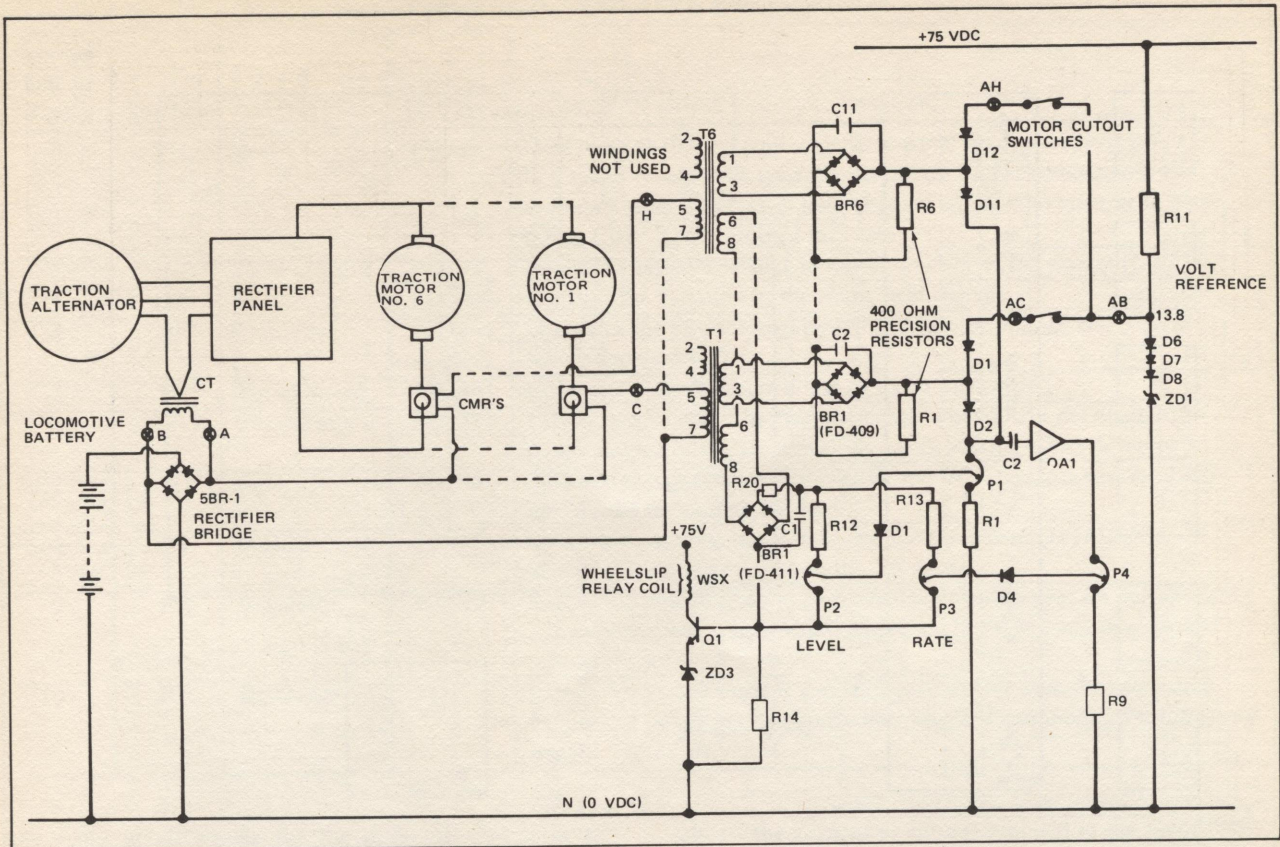


FIG. III-38. TYPICAL CMR WHEELSLIP SYSTEM FOR "C" LOCOMOTIVE.

A current transformer (CT) is connected in one phase of the traction alternator circuit. Its secondary winding furnishes square wave power for the CMR's at a frequency determined by engine speed. The output of this current transformer is regulated at 74 volts by a bridge rectifier, which diverts the excess current peaks into the locomotive battery.

WARNING: A current transformer *MUST NEVER* be permitted to operate in an open circuit condition, i.e., with the traction alternator under load and the current transformer to battery circuit open. Dangerous voltages develop during this condition, and personal injury could result.

Also furnished is a test circuit which provides a quick manual check of the system. This includes a lamp (WSL) and Toggle switch (S1) mounted on the panel frame adjacent to the instruction plate. Operation of the Toggle switch introduces simulated wheelslip signals (LEVEL or RATE) to the panel. This action should cause the panel to function and initiate corrective action on the locomotive.

MAINTENANCE NOTES

1. If Automatic Sanding does not function, check for a missing jumper bar between Terminals AL and AM, especially if panel has been replaced.
2. Cold solder joints can be a major source of trouble on printed circuit cards which have been repaired due to failure or change of parts.
3. The wheelslip relay (WSX), located on the left end of the card rack, is an 11-pin plug-in device containing three sets of double-throw bridging contacts. Periodically tighten wing nut to keep relay in place.
4. Terminal connections of all CMR reactors should be clamped between two metallic surfaces to prevent loosening of the connections due to possible cold flow of the potting compound.
5. Check for loose current transformer coil, with locomotive shut down and open battery switch. If loose, secure at terminal board end with a nylon Ty-Wrap*.

*Product of Thomas Betts Co.

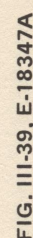
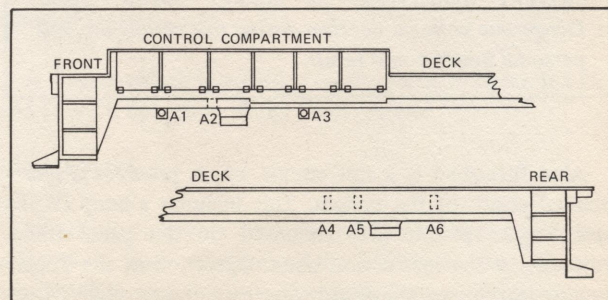


FIG. III-40, E-22208

- side of the deck, or to the control compartment directly, for the No. 1 and No. 3 motor cables.

DESCRIPTION

CHEC is a new excitation system for GE diesel-electric locomotives of which the FL138 Excitation Panel is the major component. The panel contains ten blue-face 44-pin cards. It has other electrical components in its high-voltage section. Fig. III-41. The first nine cards from the left are



III-22

TABLE III-VI, CARD DATA AND FUNCTION

Position (Left to Right)	Symbol	Card Title	Card No.	Function
1	TC	Test	FD732	Card reserves the left contact strip in panel for replacement by CHECKIT plug during system tests or checks. No components are mounted on it; however, it has interlock wiring, and must be in place unless CHECKIT is plugged in.
2	FT	Field Control	FD733	Provides a variable current to the shunt field of the exciter (GY27).
3	MD	Modulator	FD734	Controls the variation in the shunt field current.
4	MP	Multiplier	FD735	Generates the power signal by multiplying the voltage and current signals supplied to it.
5	TS	Turbo Speed	FD736	Generates a signal proportional to turbo-rotor speed.
6	CP	Comparator	FD737	Determines which of the various signals will control the locomotive power output or the amount of dynamic braking effort developed.
7	FL	Filter	FD738	Smooths signals from ACCR, BCCR and VCR reactors and furnishes two signals to comparator card.
8	OS	Oscillator	FD739	Generates a 400 Hz signal to excite the three reactors (ACCR, VCR, BCCR) and supplies power to the RG card.
9	RG	Regulator	FD740	Supplies regulated positive and negative 15-volt power for certain cards and contains four relays which repeat the Throttle command on MU trainline wires.
10	RF	Reference	FD—	Presets the power, current and voltage limits for each throttle notch, furnishes a power match signal when specified and modifies turbo speed signal.

the same in all panels for the different models of GE locomotives, Table III-VI. The tenth, or Reference Card, is different for each model of locomotive.

PRINCIPLE OF SYSTEM OPERATION

The control of the power supply on a diesel-electric locomotive is dependent on the proper operation of the excitation system and the engine governor. The excitation system, after considering all the circumstances it can sense,

adjusts the amount of current supplied to the shunt field of the GY27 exciter. This determines where on the constant horsepower portion of the output curve the locomotive power plant will operate — whether at a high, medium or low current point — which corresponds to a low, medium or high voltage (points A, B and C on Fig. III-42). Thus, the electrical transmission system must be regulated to get maximum efficiency in applying the engine output to drive the locomotive's traction motors.

Several external signals are required for proper operation of the FL138 panel. This includes signals from the turbo-rotor, engine governor, ACCR, BCCR and VCR reactors. Then, the following signals are generated within the panel: a 400 Hz oscillator output, current and voltage limit voltages, power limit reference and an indication of the Throttle handle notch position from the lead locomotive.

MOTORING

Three reference voltages are developed during motoring for the eight Throttle handle positions:

1. Power Limit
2. Voltage Limit
3. Current Limit.

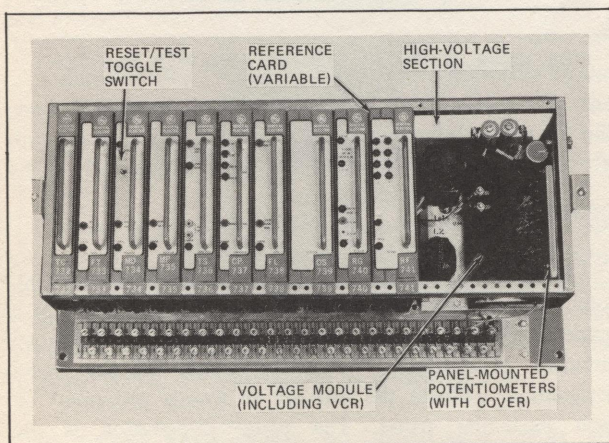


FIG. III-41. FL138 EXCITATION PANEL WITH HIGH-VOLTAGE SECTION EXPOSED.

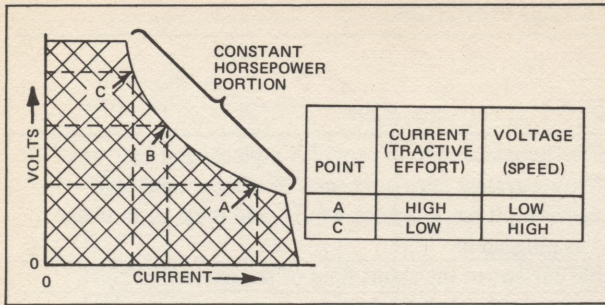


FIG. III-42. CHARACTERISTIC POWER SUPPLY OUTPUT CURVE.

DYNAMIC BRAKING

Three feedback signals are used during dynamic braking:

1. ACCR — represents current in the traction motor fields.
2. BCCR — represents current in the traction motor armature and braking grid.
3. VCR — protects the system by overriding BCCR signal if alternator voltage should rise above normal value.

MAINTENANCE

This panel should require very little maintenance. However, it must be kept free of dirt and other foreign material. The cards on this panel mount static electronic components under a protective coating. Thus, vibration is minimized and cleaning can be accomplished by blowing with low pressure, dry air.

WARNING: When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.

Periodically inspect the cards and the panel wiring for damaged components or insulation and be sure all wire connections are tight.

QUALIFICATION FOR SERVICE

Refer to Table III-VII for qualification for service.

WARNING: Electrical shock can cause serious or fatal injury. Proper precautions should be observed by personnel performing the trouble-shooting and adjustments.

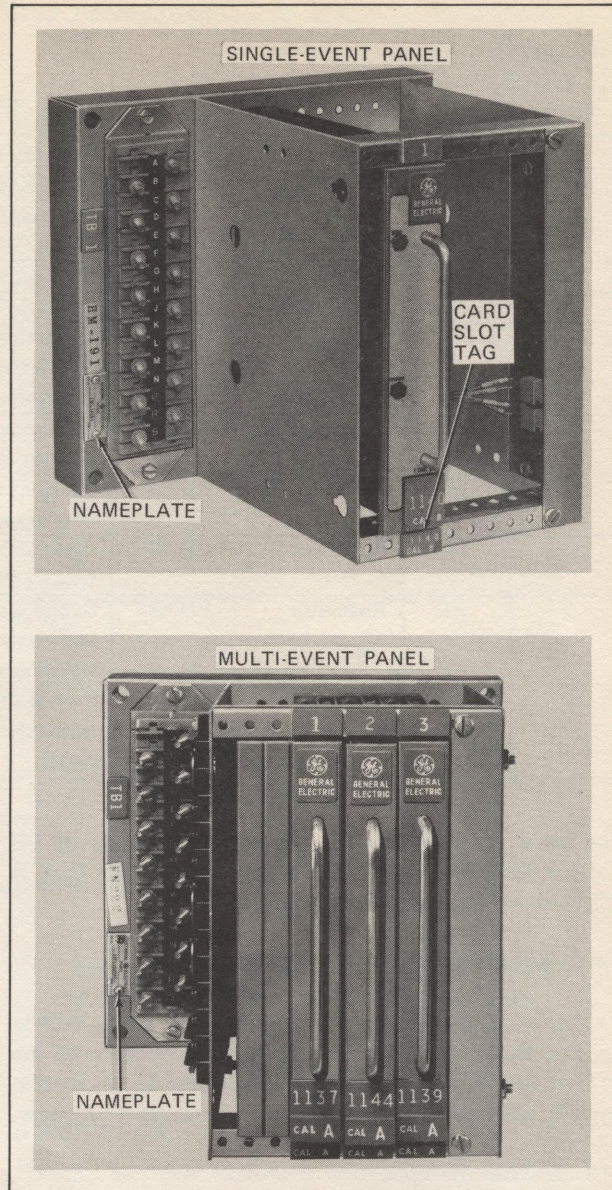


FIG. III-43. TYPICAL SINGLE AND MULTI-EVENT FL182 PANELS.

SPEED EVENT PANEL

DESCRIPTION

The Type FL182 Speed Event Panel provides one, two, four, six or eight speed-event signals. A speed event is a predetermined vehicle speed where some change in control circuitry is desired. The suffix letters in the panel designation indicate the number of events generated by each particular panel. The panel designation is the nameplate number, Fig. III-43. For example, in nameplate 17FL182B1, the B is the suffix letter indicating panel form.

FIG. III-42, E-20345

FIG. III-43, E-24599

TABLE III-VII, PROCEDURE FOR QUALIFYING LOCOMOTIVE FOR SERVICE

Procedure	Engine Shutdown	Engine Running
1. Check locomotive EC panel for a lit REDUCED EXCIT indicating light. a. If ON, the locomotive is in the reduced excitation mode. Open the Forward Control Compartment door and press the Toggle switch on the MD card to RESET. b. Indicating light will go OUT with operation of Reset Switch on MD card. c. To verify whether fault remains or has cleared, locomotive must be set for Motoring, air brakes set, reverser thrown, GF in ON position, EC switch in RUN position and isolate all other units. d. Move Throttle handle to Notch 1, until unit starts to load. e. When indication of loading is observed on loadmeter of faulty locomotive, return Throttle handle to IDLE and note whether indicating light is now ON or OFF on faulty locomotive. f. If indicator relights, go to the Control compartment and check all cards for proper location and assure they are securely plugged in.		X (Run)
2. The two red LED lights on the RG card (FD740) should be ON when the +15 vdc and -15 vdc power supplies are functioning. If not, change out this and/or the OS card (FD739).	X	X (Start or Run)
3. Move the Toggle switch on MD card (FD734) to TEST position to simulate a fault, causing the panel to go to the reduced excitation mode. The red LED on this card (Field Switch Light) should come on and stay lit until Toggle switch is moved to the RESET position. As the switch is moved, you should hear the EF relay operate.	X	X (Start or Run)
4. Check terminals for loose connections, and wires for charred or discolored insulation. Replace any damaged wires or hardware and tighten any loose connections.	X	X (Start)
CAUTION: <i>The eight panel mounted potentiometers are factory sealed and should not be tampered with, otherwise equipment may be damaged.</i>		
5. Check that cards are in their assigned locations and that card numbers agree with panel numbers.	X	X (Start or Run)
6. Check that the RF (10th) card is the proper one for the model of locomotive on which installed.	X	X (Start or Run)

Each form of the card has separate, selected resistor and capacitor values to determine operating range for each speed event.

A series of two to eight potentiometers is located on the panel end-sheet to set the speed-event points. On the single-event panel (17FL182B, etc.), potentiometer P7 will adjust the drop-out (DO) and P8 will adjust pick-up (PU).

On most multi-event panels the other speed events are provided with only one adjustment. Usually, the pick-up value is the one to be calibrated. The drop-out will then be predetermined by the value of a fixed resistor on the FD-event cards. Conversely, if it is desired to set the drop-out speed, the pick-up will be predetermined.

In special cases where no speed adjustments are permitted, potentiometers are replaced with fixed resistors on the speed-event cards.

The a-c speed sensor signal is converted to d-c on the FD1140 card for single-event panels, and on the FD1137 card for all other forms of the panel. A fixed resistor, RS1, is preselected by test for the proper scaling of a particular combination of speed sensor and speedometer scaleplate.

A wheel-wear panel (FM379) for locomotive applications is used in conjunction with, and sometimes attached to, the FL182 panel when speed indication is provided.

NOTE: *When replacing an FL182 panel with wheel-wear panel attached, be sure new panel is complete with same attachment.*

The panel contains one, two or three cards which plug into a metal frame that also mounts terminal boards, potentiometers and plug-in receptacles. See Fig. III-44 for interconnection diagram for single-event panel, and Fig. III-45 for a multi-event panel.

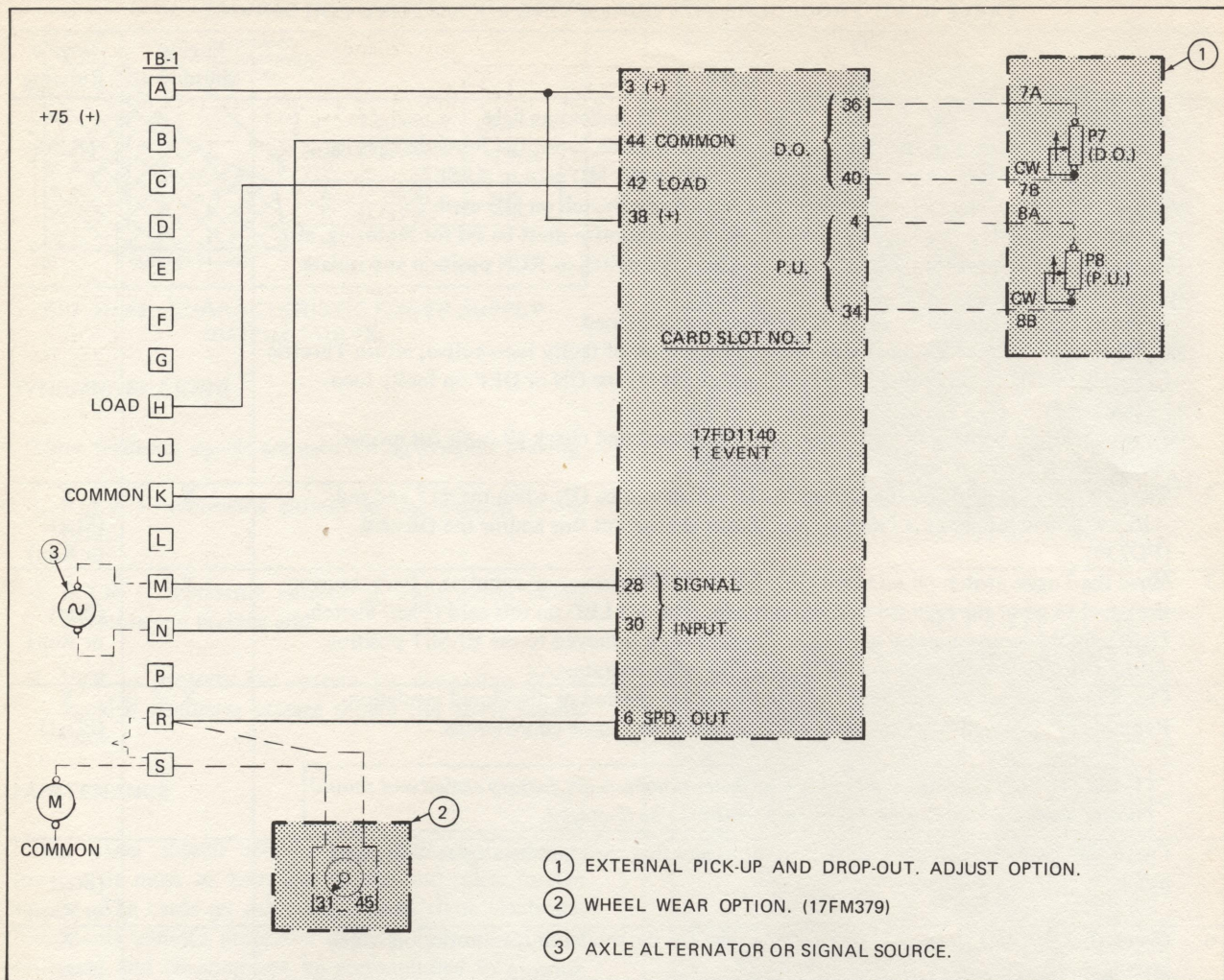


FIG. III-44. BLOCK DIAGRAM FOR FL182 SINGLE-EVENT PANEL.

CARD DESCRIPTION

The cards used in the panel are as follows:

FD1137 Tach Receiver Card — contains two separate tachometer channels, a voltage regulator, a frequency-to-voltage converter for use by speedometers, a +12 to 18 vdc source for excitation of external active sensors and a test oscillator for use in self-test, when desired.

FD1138 Four-Channel Speed-Event Card — contains four speed-event channels, each of which will energize loads up to one amp.

FD1139 Two-Channel Speed-Event Card — contains two speed-event channels, each of which will energize loads up to one amp.

FD1140 Voltage Regulator and Speed-Event Card — contains a voltage regulator, a tachometer channel, one speed event and a test oscillator circuit. Maximum speed-event load current is one amp.

FD1144 Four-Channel Speed-Event Card — contains four speed-event channels. All output loads are *energized* up to a set frequency and *de-energized* at frequencies above that point. Maximum load current is one amp.

MAINTENANCE

The panel requires very little maintenance; however, it must be kept free of dirt and other foreign material.

Cleaning can be accomplished by blowing dry, compressed air into and around the panel.

FIG. III-45, E-22658A

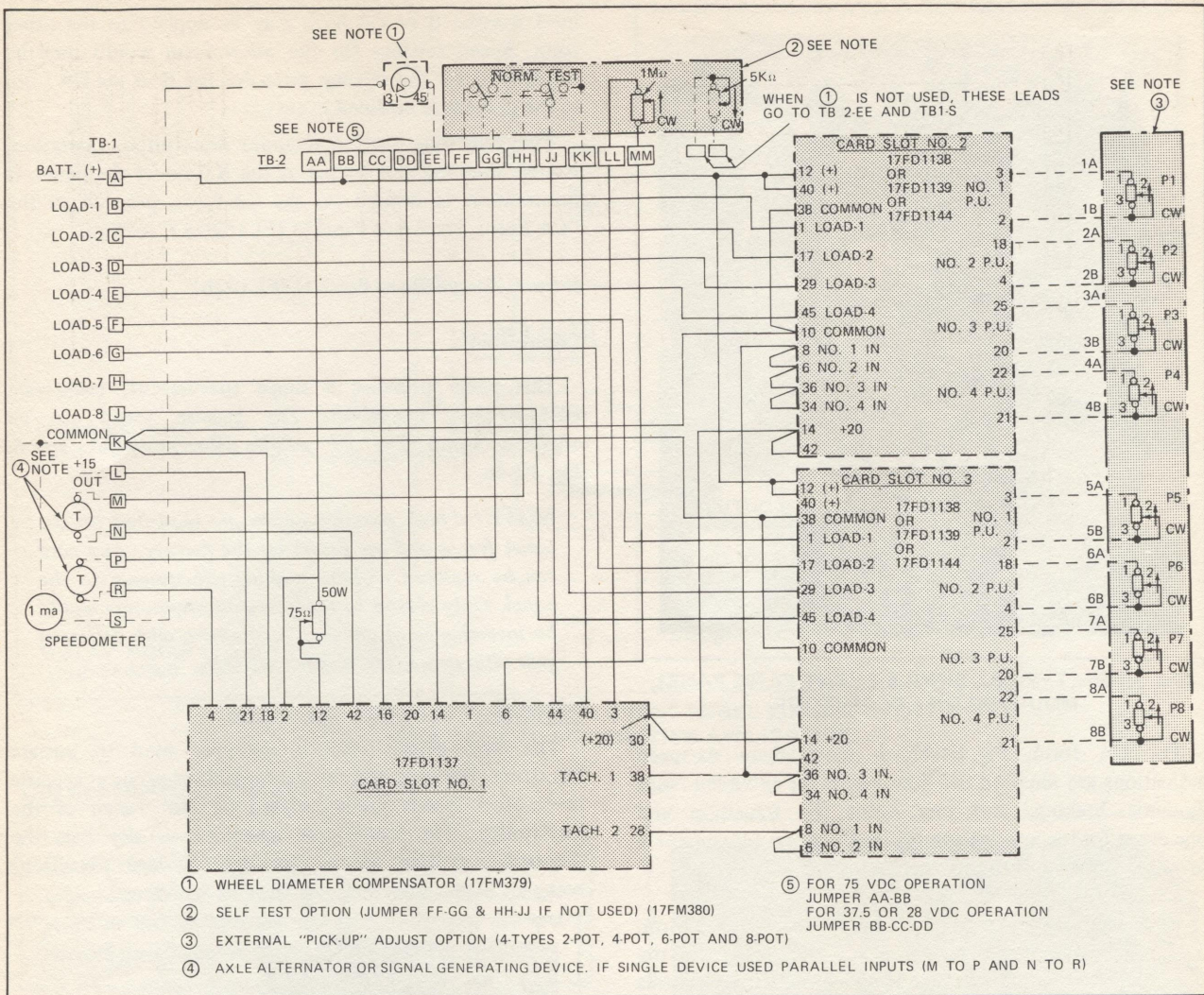


FIG. III-45. BLOCK DIAGRAM FOR FL182 MULTI-EVENT PANEL.

WARNING: When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.

The cards in this panel have static components mounted on them under a protective coating, thus minimizing vibration of components.

CAUTION: Power should be removed when pulling or replacing electronic cards to prevent electrical damage to the cards.

Periodically inspect the cards and the panel wiring for damaged components or insulation, and assure all wire connections on panel are tight.

OPERATION, TROUBLE-SHOOTING AND TESTING

The following operation, trouble-shooting and testing section describes two specific FL182 panel applications. Both applications are for a diesel-electric road locomotive. Since many forms of the FL182 panel exist, only the single-event B form (17FL182B), Fig. III-46, and the six-event CA form (17FL182CA), Fig. III-47, will be described.

NOTE: The panel form is indicated by the last letters on the panel identification nameplate. See Figs. III-43, III-46 or III-47 for nameplate location.

The B form of the panel, Fig. III-46, provides one speed event and is used when a single-speed indication is required, like for transition. Pick-up and drop-out adjustments are provided.

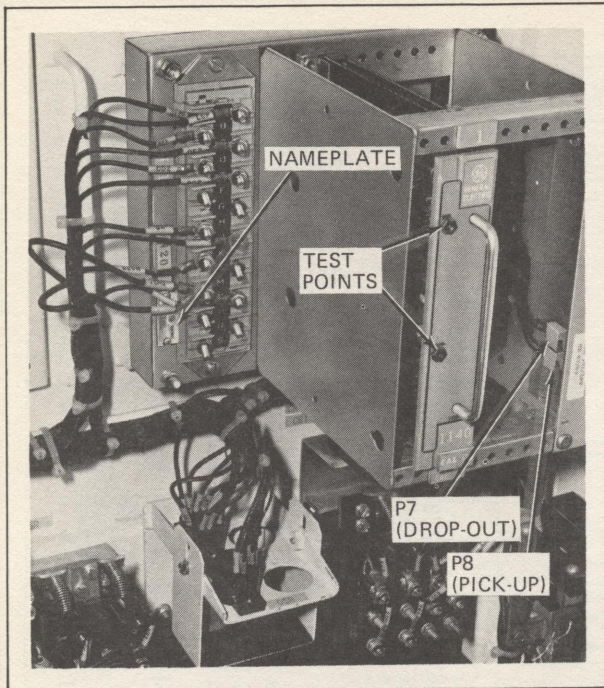


FIG. III-46. TYPICAL SINGLE-EVENT FL182 PANEL MOUNTED ON LOCOMOTIVE.

The CA form, Fig. III-47, is used where six-speed indications are required like four events for extended-range dynamic braking, and one event for transition and one event for locomotive overspeed. Only one adjustment is provided for each of the six events.

When working with a panel other than the B or CA form, determine which form the panel most closely resembles; the B or the CA form. Basic operation of other panel forms may be the same as the B or the CA form, differing only in cards, numbers or speed settings. If this is so, the method

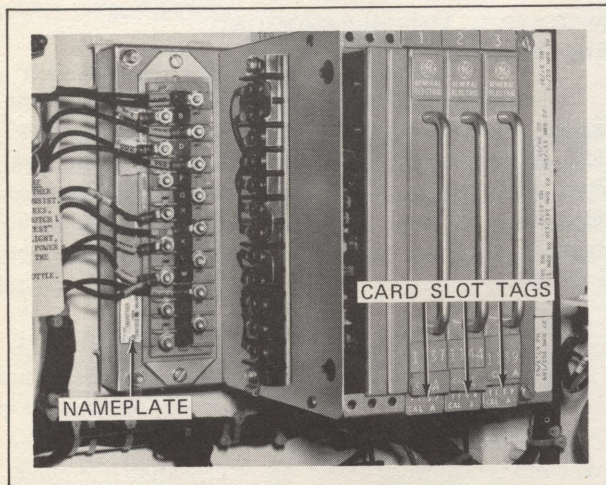


FIG. III-47. TYPICAL MULTI-EVENT FL182 PANEL MOUNTED ON LOCOMOTIVE.

used for the B or CA form may be applied to the other form. Speed settings for the other form would then be substituted for the settings given for the B or the CA form in the procedure outlined in text.

The following section includes description, operation, trouble-shooting and testing of the B form of the panel. If information is desired on the CA form, proceed to the "CA Form, Six-Event Panel (17FL182CA)" section.

B Form, Single-Event Panel (17FL182B)

Description

This panel provides a single speed-event, using one FD1140 card, Fig. III-46. The pick-up speed can be adjusted using P8; P7 adjusts the drop-out speed, Fig. III-48.

NOTE: These potentiometers are mounted on the panel frame and are preset by the factory. Any card can be replaced without making adjustments to the panel. Only reason to readjust potentiometers would be interchange of panel to locomotive with different gear ratio or transition speed settings.

Operation

The single-event panel is normally used to initiate transition. Forward and reverse transitions occur at specific locomotive speeds predetermined by the design of the locomotive. The locomotive schematic usually lists the required transition speeds; pick-up (forward transition) being set higher than drop-out (reverse transition).

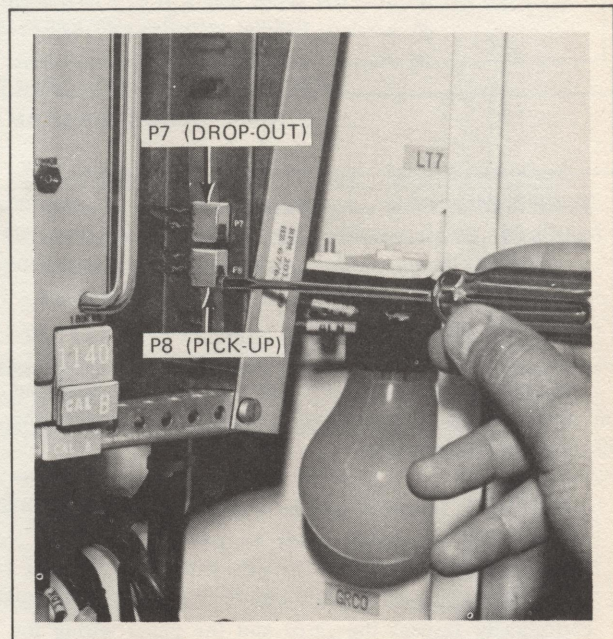


FIG. III-48. ADJUSTMENT OF TYPICAL SINGLE-EVENT FL182 PANEL.

FIG. III-46, E-24600

FIG. III-47, E-24601

FIG. III-48, E-24602

FIG. III-49, E-24605

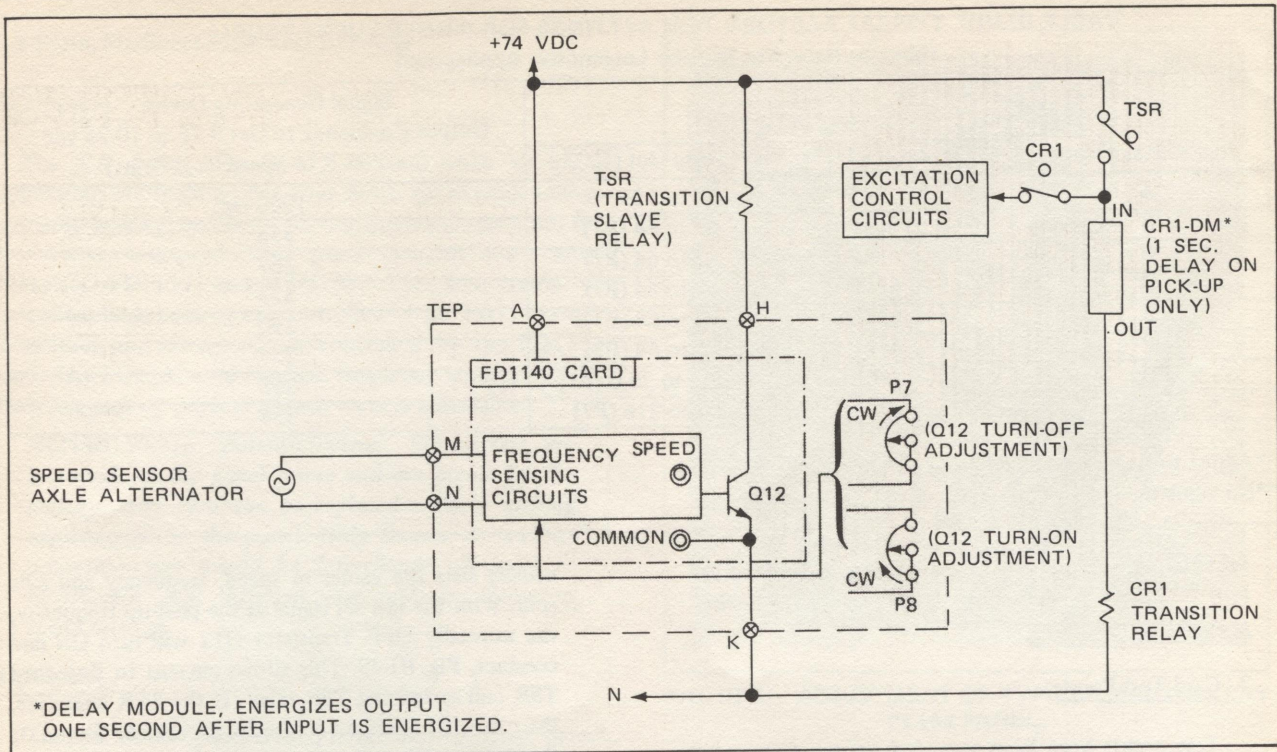


FIG. III-49. 17FL182B TRANSITION EVENT PANEL (SINGLE-EVENT TYPE) FOR A TYPICAL LOCOMOTIVE APPLICATION.

Trouble-Shooting and Testing

CAUTION: Always refer to the locomotive schematic for the exact speed settings. The speeds given in this section are examples only and are not correct for all applications.

The following describes a method for trouble-shooting, testing and adjusting the B form single-event panel. Refer to Fig. III-49 during the following description. The locomotive schematic for the specific locomotive being repaired should also be referred to since Fig. III-49 cannot represent all applications.

NOTE: The following steps will apply to the panel only. It is assumed the axle alternator circuit and other locomotive wiring to the panel is operating properly.

1. Connect Test Set

Remove one axle-alternator wire from the transition panel (TEP), Terminal M or N. Connect an a-c signal producing device to Terminals M and N. The TM14, MM37 or MM26 test set can provide this signal, Fig. III-50.



FIG. III-50. CHECKING FL182 PANEL USING TM14 TEST SET.

FIG. III-50, E-24603

TABLE III-VIII, TYPICAL FACTORY TEST SETTINGS FOR SINGLE-EVENT PANEL
(Must be Reset For Specific Locomotive Application)

FL182 Panel Form	Load on TB1-H		Signal Generating Device Output Frequency to Get 9.75 to 10.25 vdc (on TB1-R or Speed Test Point)
	Pick-Up (Hz)*	Drop-Out (Hz)*	
A	875 to 925**	805 to 855**	1000 Hz
B	66 to 68 (P8)	62 to 64 (P7)	358
C	66 to 68 (P8)	62 to 64 (P7)	267
D	66 to 68 (P8)	62 to 64 (P7)	323
E	66 to 68 (P8)	62 to 64 (P7)	290
F	66 to 68 (P8)	62 to 64 (P7)	255
H	26.2 to 27.8 (P8)	19.4 to 20.6 (P7)	358
J	223 to 237 (P8)	204 to 216 (P7)	358

*Adjust to Accuracy shown using potentiometer indicated.

**No adjustment provided on this panel.

NOTE: Any signal-generating device can be used as long as a 2-vp-p (minimum) signal is provided at the proper frequencies.

2. Card Test Points

Test points have been provided on the front of the FD1140 card, Fig. III-46. The test points are labeled SPEED and COMMON. The information provided by these test points is not essential for checking the operation of the FL182 panel. These test points are provided for special applications. If the test-point values are observed, the following information will apply:

- The SPEED (+) to COMMON (–) test points will produce a 0-10 vdc reading depending on the frequency of the axle alternator or test-set signal input to the FL182 panel.
- The voltage to frequency relationship differs for each panel form and the FD1140 card calibration.
- Table III-VIII lists the axle alternator or test-set frequency that produces a 10-vdc test-point reading.
- The relationship between test-point voltage and axle-alternator frequency is linear.

3. Check Panel Operation (Pick-Up)

Set the test-set or signal-source frequency at the FL182 panel pick-up value. Normally this pick-up value will be the locomotive transition speed which is listed on the locomotive schematic. The schematic

usually lists the values in speed, frequency and axle rpm. With the test-set signal at the pick-up frequency, the normally OFF Transistor Q12 will turn ON and conduct, Fig. III-49. This allows current to flow thru TSR coil energizing TSR relay. If the TSR energizes, the panel has operated correctly; proceed to Step 4. If the panel did not operate correctly, proceed to Step 5.

4. Check Panel Operation (Drop-Out)

With the FL182 pick-up operating properly, check the drop-out speed setting. Reduce the test-set or signal-source frequency to the drop-out value. Below this drop-out value the panel should de-energize the coil (Q12 turn-off). If the drop-out sequence does not operate, proceed to Step 5. If the drop-out sequence operates properly, the panel is operating properly. Remove test equipment and restore circuits to normal.

5. Change FD1140 Card

If the FL182 panel does not operate at the proper pick-up or drop-out frequency (speed), try other frequencies to determine if the panel operates at all, then change the FD1140 card. Cards should be changed before panel adjustment is attempted.

NOTE: When changing the FD1140 card, make sure the CAL (calibration) letter on the card front matches the CAL letter on the panel slot tag, Fig. III-43. For example, the FD1140 CAL B card must be replaced by an FD1140 CAL B card. The CAL B indicates that factory selected resistors and capacitors are built into the card for a specific frequency range.

When the card is changed or repaired, return to Step 3 for retesting.

CA Form, Six-Event Panel (17FL182CA)Description

The CA Form, Fig. III-47, is used when six speed indications are required like four events for extended-range dynamic braking; one event for transition and one event for locomotive overspeed. This panel contains three cards: FD1137, FD1144 and FD1138. The four events of extended-range braking are controlled by the FD1144 card. Transition and overspeed are controlled by the FD1139 card. The FD1137 card contains frequency sensing circuits. Only the pick-up portion of each event is adjustable.

NOTE: These potentiometers, Fig. III-51, are mounted on the panel frame and are preset by the factory. Any card can be replaced without making adjustments to the panel. Only reason to readjust potentiometers would be interchange of panel to locomotive with different gear ratio or transition speed settings.

Operation

The multi-event panel is used to initiate transition, detect locomotive overspeed and control the extended-range dynamic-braking contactor sequence, Fig. III-52.

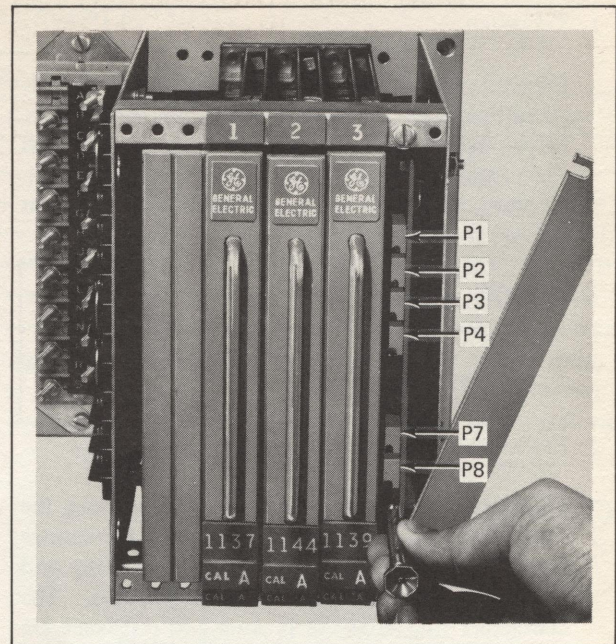


FIG. III-51. ADJUSTMENT OF TYPICAL MULTI-EVENT FL182 PANEL.

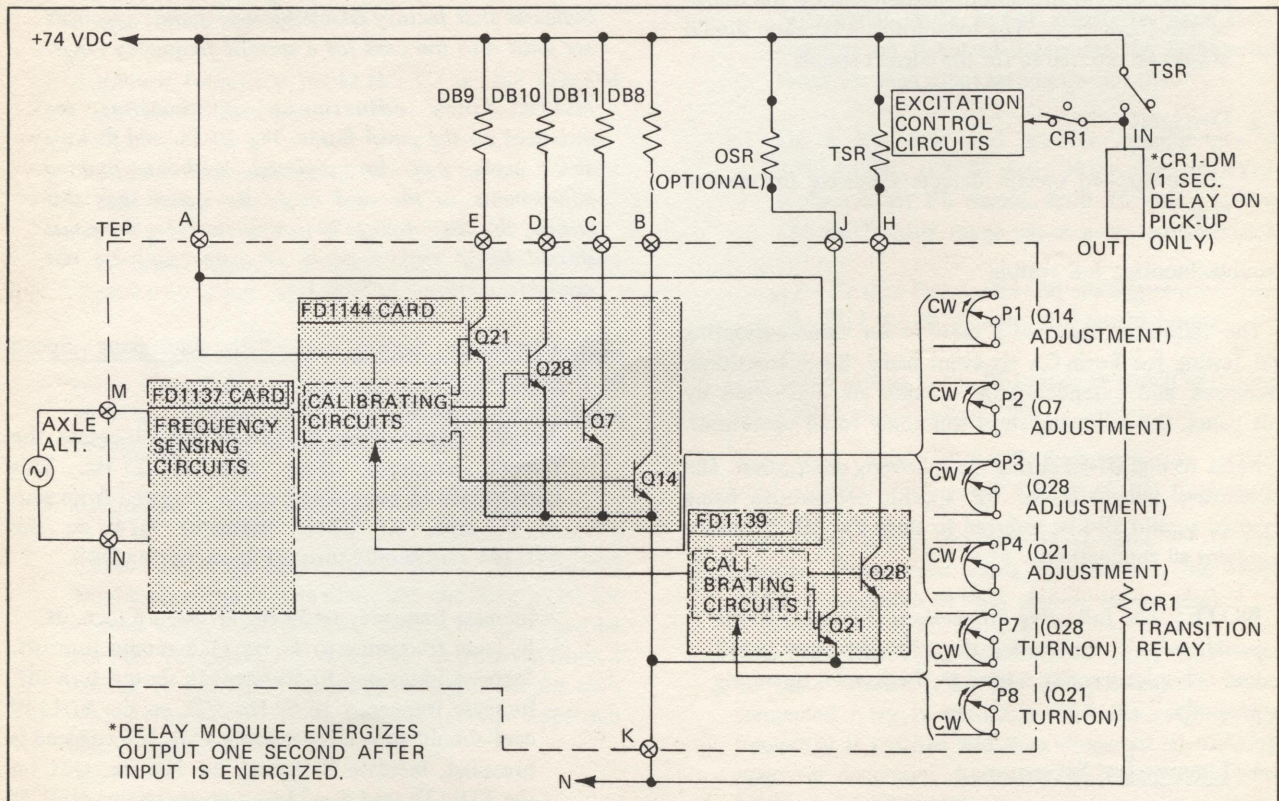


FIG. III-52. 17FL182CA TRANSITION EVENT PANEL (MULTI-EVENT TYPE) FOR A TYPICAL LOCOMOTIVE APPLICATION.

1. Transition

Forward and reverse transitions occur at specific locomotive speeds predetermined by the design of the locomotive. The locomotive schematic usually lists the required design transition speeds, pick-up (forward transition) being set higher than drop-out (reverse transition).

CAUTION: *Always refer to the locomotive schematic for the exact speed settings. The speeds given in this section are examples only and are not correct for all applications.*

2. Extended-Range Dynamic Braking

The purpose of extended range is to improve the effectiveness of dynamic braking at low locomotive speeds. This is done by altering the braking grid resistance as locomotive speed reduces. The contactors that alter the braking grid resistance are initially controlled by the FD1144 card, Fig. III-52. Transistors Q21, Q28, Q7 and Q14 are the switches that control the contactor sequencing.

Extended-range contactor sequencing occurs at specific locomotive speeds determined by the design of the locomotive. The locomotive schematic should always be referred to for the correct speeds.

3. Overspeed

The overspeed system detects excessive locomotive speed.

Trouble-Shooting and Testing

The following describes a method for trouble-shooting and testing for Form CA six-event panel. Since transition, overspeed and extended-range braking are controlled by this panel, the following steps will apply to all operations.

Refer to Fig. III-52 during the following description. The locomotive schematic for the specific locomotive being repaired should also be referred to since Fig. III-52 cannot represent all applications.

NOTE: *The following instructions will apply to the panel only. It is assumed the axle-alternator circuit and other locomotive wiring to the panel is operating properly.*

1. Connect Test Set

Remove at least one axle-alternator wire from the transition panel (TEP) Terminal M or N. Connect an

a-c signal producing device to Terminals M and N. The TM14, MM37 or MM26 test set can provide this signal, Fig. III-50. Any signal-generating device can be used as long as a 2-vp-p (minimum) signal is provided at the proper frequencies.

2. Zero Signal Input to Panel

With the test-set frequency set at zero Hz (zero input to panel), Q21, Q28, Q7 and Q14 on the FD1144 card will be turned on energizing DB9, DB10, DB11 and DB8, Fig. III-52. Q28 and Q21 on the FD1139 card will be turned off. If Q21, Q28, Q7 and Q14 are not turned on, replace FD1137 CALA and/or the FD1144 CALA card if spares are available.

To check further — if 15 v is available between L (+) and K (–) on TB-1, Fig. III-45; expect FD1137 card probably is not the one at fault.

NOTE: *When changing cards, make sure the CAL (calibration) letter on the card front matches the CAL letter on the panel slot tag, Fig. III-47. For example, the FD1137 CALA card must be replaced by an FD1137 CALA card. The CALA (calibration A) indicates that factory selected resistors and capacitors are built into the card for a specific frequency range.*

NOTE: *Since adjustment potentiometers are mounted on the panel frame, Fig. III-51, and factory set, cards can be replaced without making adjustments to the card or to the panel. For this reason, the first attempt in trouble-shooting the panel should be to replace cards. If spare cards are not available, continue to Step 3.*

3. Checking Operation with Increasing Speed (Frequency)

Assume values given in Table III-IX. Increase the test-set frequency from zero to 27 Hz. This corresponds to increasing locomotive speed from zero to 9.7 mph. At 27 Hz transistor Q14 on the FD1144 card should turn off de-energizing DB8.

- Increase frequency to 39 Hz; Q7 should turn off.
- Increase frequency to 47 Hz; Q28 should turn off.
- Increase frequency to 58 Hz; Q21 should turn off.
- Increase frequency to 67 Hz; Q28 on the FD1139 card should turn on energizing TSR. If overspeed is provided, increase frequency to 208 Hz. Q21 on the FD1139 card should turn on energizing OSR. If none of the events work, expect FD1137 card is faulty; otherwise, replace the FD1144 card.

TABLE III-IX, SIX TYPICAL EVENT SETTINGS
(For a Diesel-Electric Road Locomotive Equipped with Extended-Range Dynamic Braking,
Transition and Overspeed. (40-In. Wheels, 74/18 Gearing, 3000 Hp))

Event		MPH, Increase/Decrease	RPM, Increase/Decrease	CPS (Hz), Increase/Decrease
Extended range, dynamic braking contactor sequence	DB8	9.7/8.5	82/72	27/24
	DB11	13.9/12.5	117/105	39/35
	DB10	16.7/15.0	141/126	47/42
	DB9	20.6/18.9	173/159	58/53
Transition		24.0/22.5	202/189	67/63
Overspeed		74.0/70.5	623/593	208/197

If Q28 or Q21 on the FD1139 card did not operate, replace the card. Repeat Step 3 to verify new cards, if changed.

4. Checking Operation with Decreasing Speed (Frequency)

Set the test-set frequency as 208 Hz or higher. Reduce the frequency to 197 Hz. Q21 on the FD1139 card should turn off. Reduce the frequency to 63 Hz. Q28 on the FD1139 card should turn off. Reduce the frequency to 63 Hz. Q28 on the FD1139 card should turn off.

— Reduce frequency to 53 Hz; Q14 on the FD1144 card should turn on.

— Reduce frequency to 42 Hz; Q7 on the FD1144 card should turn on.

— Reduce frequency to 35 Hz; Q28 on the FD1144 card should turn on.

— Reduce frequency to 24 Hz; Q21 on the FD1144 card should turn on.

If the panel did not operate as described, replace cards. If no cards are available, continue to Step 5. If all events operated as described, the panel is operating properly, proceed to Step 6.

5. Additional Trouble-Shooting

Refer to Figs. III-45 and III-52 for further trouble-shooting information; like checking panel for broken wires. Potentiometer circuits on panel can be checked for continuity using card extender in Slots 2 and/or 3. Fig. III-45 shows pin connections for each potentiometer. These values could approach 200k ohms.

6. Remove Test Equipment

Restore circuits to normal. Panel testing completed.

ADJUSTMENTS

1. Three potentiometer arrangements are used on various models of the 17FL182 panels.

a. On single-event panels (i.e. — 17FL182B, C), Fig. III-46:

- 1) P8 adjusts event settings
- 2) P7 adjusts differential range.

b. On most two, four, six and eight-event panels (i.e. — 17FL182AA-DD), Fig. III-51:

P1 thru P8 adjust event settings only. The differential range is not adjustable since fixed resistors on the card determine the differential range for each event setting involved.

c. On a few four and six-event panels (i.e. — 17FL182BC, BD, BJ and CD) intended ONLY to replace other FL panels, both the event setting and differential range adjustments are provided.

- 1) P1 thru P4 adjust event settings
- 2) P11 thru P14 adjust differential ranges.

2. The event setting is the frequency at which switching takes place on rising frequency.

This was called PICK-UP frequency on former products which turned-on a relay at that frequency.

The 17FD1138, 1139 and 1140 cards act in this manner. When these cards are involved, the event setting corresponds to relay pick-up (energizing).

The 17FD1144 card, however, does not operate in the same manner. It has an "inverted output" so the connected relay is energized until the event-setting frequency is reached and then drops-out. It picks-up again on decreasing frequency at a value of Event Setting (—) Differential.

3. Procedure — Refer to Fig. III-53, Upper Portion.

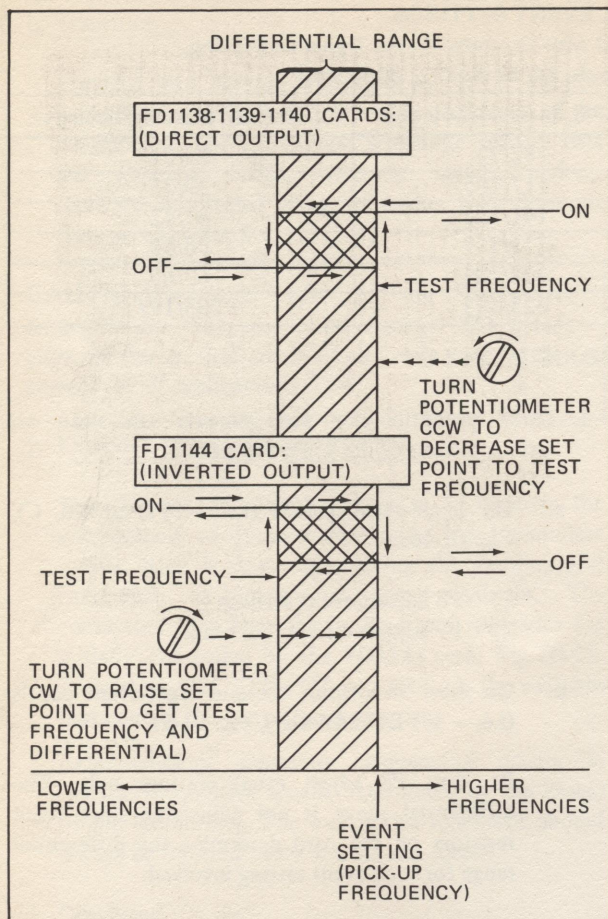


FIG. III-53. SETTING DIRECT AND INVERTED SPEED EVENTS.

a. Single-event panels, Step 1a1, and replacement panels, Step 1c1:

- 1) Adjust oscillator input frequency to desired operating point or pick-up frequency as listed on locomotive schematic (test frequency for event being checked).
- 2) If output is ON, turn appropriate potentiometer CW until output goes OFF (relay drops-out). The potentiometers are 20 turns from minimum to maximum resistance.
- 3) With output OFF, slowly turn potentiometer CCW. Stop when event goes ON (relay picks-up).

You have lowered the event setting to match the test frequency.

- 4) Decrease the test frequency to the desired drop-out value.

5) If output goes OFF, turn P7 range (P11-P14 on FD1144 card with inverted output) CW several turns to decrease differential. Increase test frequency until output goes ON then decrease it to desired drop-out value. Repeat as needed until event remains ON at drop-out setting of test frequency.

6) Turn P7 (or P11-P14) CCW slowly to increase differential range. Stop when event goes OFF.

b. Multi-event panels with FD1138, 1139 or 1140 event card. Refer to the upper portion of Fig. III-53.

- 1) Adjust test frequency to desired event setting.
- 2) If output is ON, turn appropriate potentiometer CW until it goes OFF (relay drops-out).
- 3) Turn potentiometer slowly CCW. Stop when output goes ON (relay picks-up).

c. Multi-event panels with FD1144 card. This is referred to as an inverted event card, and is used for extended range dynamic brake and some overspeed functions. Refer to Fig. III-53, lower portion.

- 1) Adjust test frequency to the value desired for turn-on during decreasing frequency (test frequency).
- 2) If output is ON, turn potentiometer CCW to lower setting until output goes OFF.
- 3) Turn potentiometer slowly CW. Stop when output goes ON. You have raised Set Point above test frequency by an amount equal to the differential range.

ANNUNCIATOR PANEL

DESCRIPTION

The 17FM369A2 Annunciator Panel is used to indicate malfunctions of equipment or systems on a locomotive. The panel is provided so a maintainer can better service a locomotive by knowing the cause of a locomotive malfunction and properly correcting it before resetting the panel and releasing the locomotive for service.

FIG. III-53, E-24682

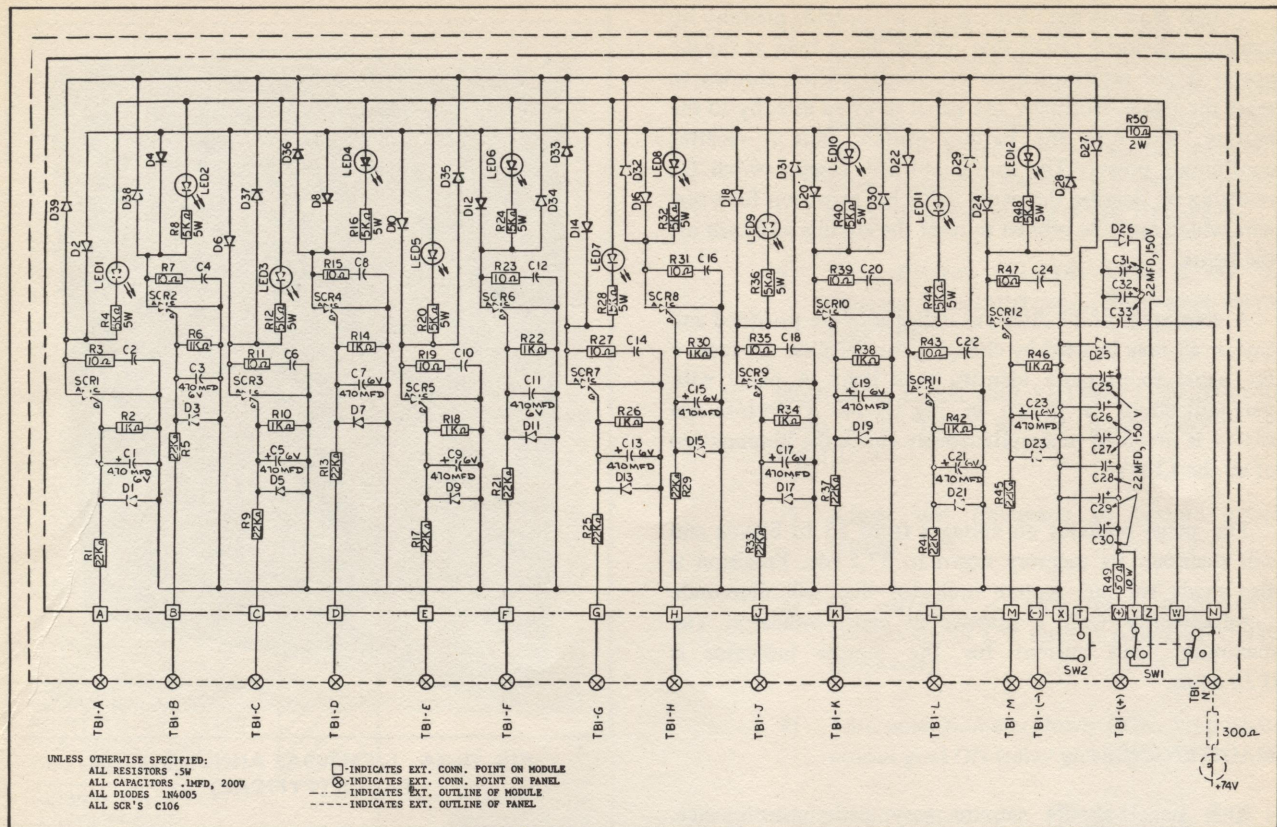


FIG. III-55. SCHEMATIC FOR 17FM369A2 PANEL.

NOTES: